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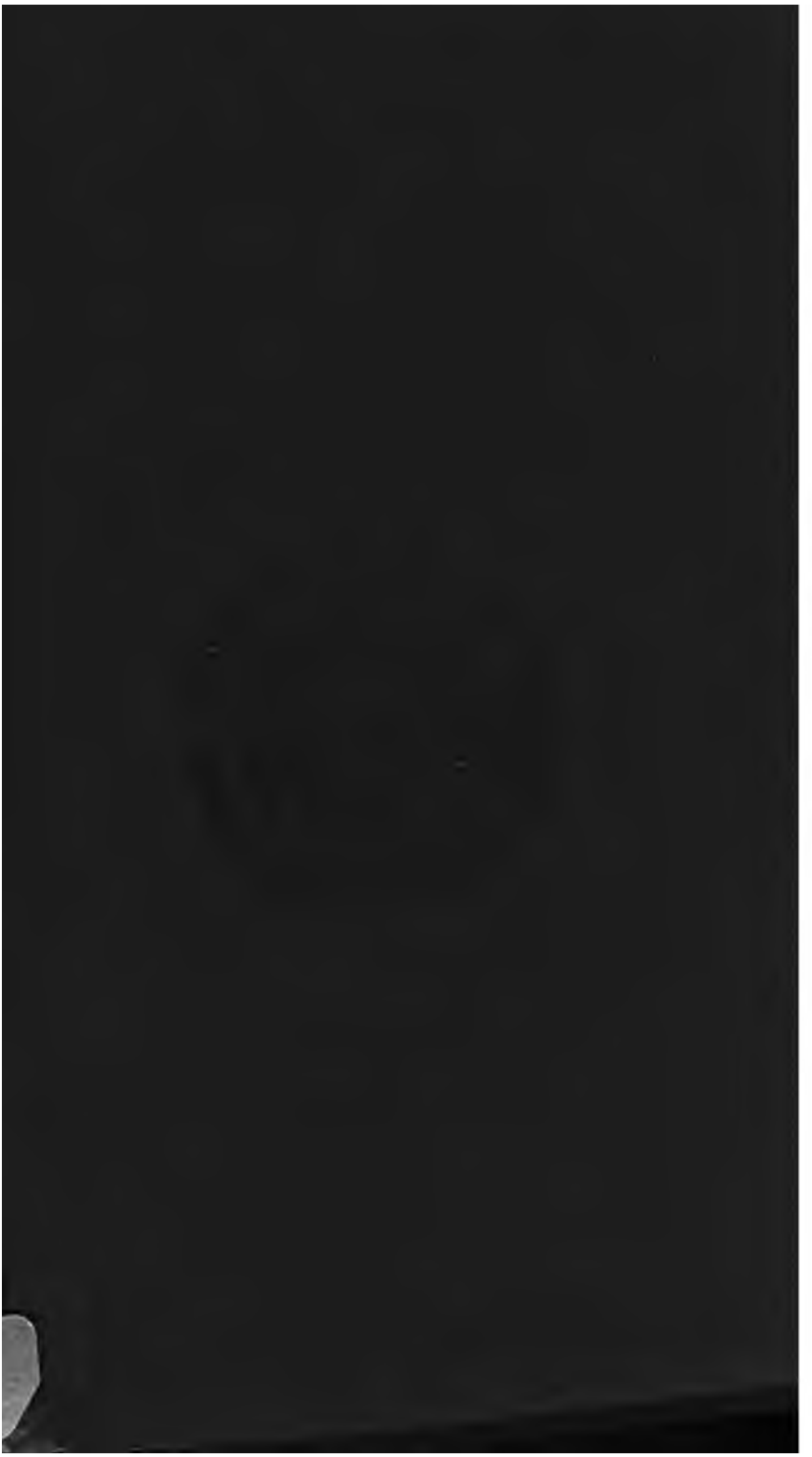
THE IRON TRADE
OF
THE UNITED KINGDOM

SIR LOWTHIAN BELL, BART., F.R.S.



THE

IRON TRADE OF THE UNITED KINGDOM

COMPARED WITH THAT OF THE OTHER

CHIEF IRON-MAKING NATIONS.

BY

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PREFACE.

THE circumstances which led to the preparation of this volume are stated in the opening paragraph. Its publication in the present form is the result of a wish expressed by the Board of Management of the British Iron Trade Association to have the views it contains circulated among the members of that body.

Mention is made, in the text, of difficulties which have been met with in compiling the statistical tables it contains. This remark applies chiefly to the earlier years which have been examined. There is, however, one of the latter, 1879, which may appear inconsistent with the years immediately preceding and following; the consumption of pig iron in the United Kingdom in 1879 being about 750,000 tons below either that of 1878 or of 1880.

This difference, although a very large one, appears to be correct, because on examining the weight of pig iron produced, according to the Government returns, with the quantity of ore smelted, there seems no reason to distrust the figures given at page 26.

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THE

IRON TRADE OF THE UNITED KINGDOM

COMPARED WITH THAT OF THE OTHER CHIEF IRON-MAKING NATIONS.

AT the request of the Earl of Iddesleigh, I have the honour of submitting to the Royal Commission on the Depression of Trade a statement containing some statistics connected with the Iron Trade of this and other nations. It will, it is hoped, as far as it goes, be of a character to afford Her Majesty's Commissioners the information they require. Should it be considered by them desirable to obtain further details, my best services will remain at their disposal.

I would remark, however, that I am unable to vouch for the strict accuracy of all the figures made use of. I shall hereafter have occasion to show that the Government returns, as given in the Mineral Statistics of the United Kingdom, are not to be entirely relied on, and that, for certain periods, they are far from complete. In making this observation I must not be understood as undervaluing the labours of Mr. Robert Hunt, to whom was originally intrusted the compilation of the statistics. No one could have worked more assiduously or more conscientiously at his duty; but with some facts given to him reluctantly and others refused altogether, my only wonder is, that he succeeded so well. It may, perhaps, be worthy of the attention of the Commissioners to suggest some means of securing greater amplitude to the metallurgical statistics of the Empire,

which upon such occasions as the present, and for the guidance of the manufacturers, could not fail to be of great value.

The present memorandum has been drawn up under circumstances which have prevented my giving it such reconsideration as might have enabled me to condense it. The work necessarily involves the aid of a good many figures which might have been curtailed. I preferred, however, to give too much rather than too little, and to leave it to the Commissioners to select such as they might deem of service.

The expense of producing metals, and consequently the market value thereof, are necessarily affected by the cost and richness of their respective ores. This observation is more especially applicable to the three most abundant metals, viz., iron, lead, and copper.

The opening up of new districts and of new countries by means of railways, and the facilities of transport afforded by the modern improvements in steam navigation, have been the principal agents in the development of new mining ground. At the present time iron ore is being conveyed by steamers from Bilbao to the Tyne, a distance of fully 1000 miles, for 5s. 3d. per ton, or about $\frac{1}{16}$th of a penny per ton per mile. This freight, it is true, leaves little or no profit for the ship, but on the authority of a large steamship owner, at the present value of provisions and coal, a moderate balance in favour of the vessel would remain were the rate 6s. per ton.

The discovery of rich deposits of ore in foreign countries has entirely changed the position of Great Britain, as a lead-producing country, in relation to Germany and the United States during the last fifteen years. This will be seen by comparing the weight of metal produced in the three countries in the years 1870 and 1884:—

	Great Britain. Tons.	Germany. Tons.	United States. Tons.
1870	73,420	60,000	25,800
1884	40,075	94,101	138,897

Great Britain has thus fallen from being the largest producer

in 1870 to being the smallest in 1884. In the matter of price, this metal has dropped from £21., which was the average value during the four years ending 1876, to £10. 5s. per ton in 1884. This great reduction has so affected the price of ore, that the same quality of this mineral which was in former years sold for £13. 5s. per ton is now only worth £6. 15s.—a change which has necessitated the closing of several mines in this country.

The copper market has experienced fluctuations not less remarkable than the case just mentioned, and here again it is the mines of Great Britain which have suffered by the change. In 1870 England and Wales produced 34,200 tons of copper; but even then only 7175 tons of this quantity were the product of British mines, or less than half that of 1861. In 1884 the weight of copper furnished by our smelters rose to 57,819 tons, of which only 3350 tons were obtained from our native ores. In the year 1850 the production of the world was between 40,000 and 50,000 tons; in 1870 it was something beyond 80,000 tons; in 1880, 120,000 tons; and to-day it is estimated to have reached 200,000 to 220,000 tons. Best selected copper, which in former years ranged from £85. to £119. per ton, only averaged £54. per ton over last year. This great fall in value is due in a great measure to cheaply worked foreign ores, but partly to some of such ores containing silver and some gold, from which the smelter derives a considerable profit, and by reason whereof he is enabled to sell the copper at a reduced price.

Although, as in the case of lead and copper, very large quantities of iron ore required in our works are now brought into Great Britain from foreign countries, this has arisen from no want of the mineral within our own boundaries, nor, taking it as a whole, from an inability to compete in economy of production with any nation in the world. In recent years the demand for pig iron, suitable for the manufacture of steel, increased to such dimensions that the British mines, affording the proper quality of ore, became incapable of meeting the pressure on their resources. As a consequence, the cost of this mineral to

produce one ton of pig iron rose greatly in comparison with that of certain other descriptions. In the year 1870 the difference between the two kinds did not exceed 8s., *i.e.*, if the ore required to produce one ton of non-steel making Cleveland pig cost, at its market value, 19s., that required for one ton of Cumberland metal for steel purposes would be 27s. In 1871, in lieu of 8s., the difference was 25s.; in 1872, 23s. 3d.; and in 1873 it reached 27s. 6d. This rapid advance took place in the face of the importations of foreign ore having risen from 208,300 * tons in 1870 to 1,242,536 tons in 1873. Since then the imports have exceeded three million tons per annum, and the difference between the cost of ore for the two kinds has settled down to 8s. or 10s. per ton of iron made.

The disturbance in the value of ore occasioned by foreign importation has been increased by fresh discoveries in Great Britain itself. For the first twenty-five years of the present century the coal measures may be regarded as having been the sole source of the ironstone smelted in this country. The mineral itself lay in thin seams or in nodular masses embedded in shale. This necessitated the removal of such large quantities of sterile matter that the ironstone required to give a ton of pig iron cost from 40s. to 60s. At that time South Wales and certain Midland Counties were the chief seats of the iron trade.

According to data given in "Scrivenor on the Iron Trade," pig iron made in the neighbourhood of Dudley and Wolverhampton so late as 1854 was not remunerative when selling at £5. 10s. to £6. per ton. The quantity and cost of ironstone and coal were three tons of the former at 22s. and four tons of the latter at 10s., making together £5. 6s., to which had to be added the expense of limestone, labour, &c.

For the year 1800 the make of pig iron in Great Britain may be taken at 200,000 tons, and this may be regarded as approxi-

* To this figure probably 100,000 to 200,000 tons should be added for burnt ore from cupreous pyrites.

mately representing the consumption of the kingdom, for against the exports of 35,000 tons, 40,000 tons were imported from abroad.

By 1830 the production of pig iron had increased to 678,000 tons. The annual average exports of home-made iron had, over a period of ten years, reached more than 100,000 tons, and the balance of foreign iron remaining for our own consumption was under 15,000 tons, so that 500,000 to 600,000 tons were needed for the requirements of the United Kingdom.

Up to 1830 there were no sources of demand which could be said to correspond even remotely with the present requirements for railways and shipbuilding. The demand approaching nearest in extent to that of either of these industries was for pipes for the conveyance of water or gas, and for the greater portion of the period, 1800 to 1830, the consumption of iron for these purposes would be very small.

During the thirty-one years embraced in the period just referred to, there were great changes in the price of pig iron. It was upon two occasions as low as £3., but £7. to £9. was not an uncommon figure, and in the year 1825 the price rose to £12. It was many years after 1830 before any systematic attention was paid to manufacturing statistics in this country, so that any attempt to explain the great range of prices previously spoken of would be mere guess work.

At the commencement of the present century Great Britain was practically the only country in which pig iron was smelted by means of pit coal. In point of economy this of itself was a very great advantage, and was an effectual barrier to foreign competition in all kinds of iron except the finest sorts for cutlery and the better descriptions of steel. Nevertheless, the import duties on bars, which in 1800 were £3. 15s. 5d. per ton, were gradually increased to £6. 10s. in 1819 if conveyed in British, and £7. 18s. 6d. if in foreign, vessels. Pig iron at that time was admitted on paying 17s. 6d. per ton. Under the circumstances these high imposts were simply a tax on articles into the manufacture of which British iron did not enter.

The high prices of 1825, already spoken of, induced Mr. Huskisson to propose, in resolutions applicable to other articles also, a reduction of duties on all kinds of iron without any discrimination of the nationality of the ships in which they were carried. Some of the items which were accepted by the House of Commons were as follows:—

	Former Duty. Per Ton.	Altered Duty. Per Ton.
Bar iron—the produce of British possessions .	£1 2 2	£0 2 6
Do. do. of other countries . .	6 10 0	1 10 0
Pig-iron	0 17 6	0 10 0
Do. from British America	0 8 0	0 1 3
Iron ore	0 8 9	0 5 0

Between 1846 and 1848 the whole of these duties were repealed, and the articles enumerated are now admitted free.

The first notable departure from the use of the expensive ironstone, mentioned at page 4, was effected by the famous Black Band of Scotland, which, like the thinner seams, is also found in the carboniferous rocks. Its cheapness, and the application of the hot-blast to the smelting furnaces, produced a revolution in the iron trade, and gave ultimately to the Scotch manufacturers almost a monopoly of the trade in foundry iron. The natural advantages of fuel and ore in the county of Lanark were such, when coupled with the improvement in the smelting appliances and cheap labour, that the cost of making pig iron in some years was, I was informed by a large ironmaster, as low as 27s. 6d. per ton. This, however, was an exceptionally low rate, and before the Black Band royalty rose to the high figure it subsequently attained; 40s. would, therefore, in the cheapest times, be much nearer the cost price of Scotch foundry iron.

In 1850 the make of pig iron, as nearly as I can compute, was about 2½ millions of tons. In that year 783,482 tons of iron and steel of British make were exported, equal probably to 1,100,000 tons of pig iron, besides a large quantity of hardware, cutlery, and machinery, valued at £3,683,598. We imported 34,065 tons of bar iron, of which 5,966 tons were re-exported.

An important feature in the increased make of pig iron, which

rose from 678,000 tons in 1830 to 2½ millions in 1850, was the great extension of the Scotch iron trade already referred to, the production of which increased from 37,500 tons in the former year to nearly 800,000 tons soon after the close of the latter. Partly from railways and the extension of gas and water-works, it would appear for some time that the demand kept pace with the supply, for during the ten years ending 1839 the average price of Scotch pig was about 82s., the lowest quotation during any one year being 80s., and in 1836 it rose to 137s. The price then gradually receded until the same iron was stated to have been sold, in the year 1842, at the low rate of 32s. per ton.

At that period the utmost distress prevailed in the iron trade, entirely due, according to a leading article in the *Times* of 5th December 1842, to the enormous annual quantity of iron produced in Scotland (276,250 tons!), with which "England was deluged." The increase there was undoubtedly due to the much cheaper rate at which pig iron could be made than in any of the English seats of the iron trade; but the writer of the article referred to ascribed it to the Scotch system of banking, which he wished extended to England. Were this view correct, and had his advice been taken, presumably England would have followed the example of Scotland, and have also rushed into over-production.

In a short time after the date of this opinion being given, *i.e.*, in 1845, great excitement arose in connection with railways, which ran the price of Scotch pig iron from 32s. up to £5. 10s. per ton, and Staffordshire bars rose from £5. 6s. to £12. per ton. In reality, I believe there never was during this period any actual scarcity of iron, for of Scotch pig alone there was at the end of 1845 a quarter of a million tons in stock. These high prices were almost exclusively due to speculation fostered by interested parties, who persuaded the world, and perhaps persuaded themselves, that the future demand for iron could not possibly be met, and high rates were given for deferred deliveries of iron. The railway bubble burst within a year or two, and

iron of all kinds gradually declined in price, so that Scotch pig in 1850 only averaged 42s. 6d. to 44s. per ton.

At the period to which this recital has been brought, another rival appeared in the field, which was destined to contest the position of supremacy occupied during the previous twenty years by Scotland. This new competitor arose in the Cleveland hills situated in the North Riding of Yorkshire, and was speedily followed by the discovery in Lincolnshire and Northamptonshire of ore somewhat resembling that of Cleveland. Between 1850 and 1870 the make of pig iron in the United Kingdom was more than doubled, *i.e.*, it rose from 2½ millions to 5,963,000 tons, and of the increase, viz., 3,463,000 tons, no less than 1,622,070 tons were the produce of the mines in the three localities just named—an increase effected without the aid of the Scotch banking system, required, according to the *Times* writer, to enable England to compete with Scotland.

In order to show how the successive discoveries above referred to, and how certain changes in the manufacture of the metal, have affected the relative position of the different iron-making localities, I have prepared a table in which the quantities of pig produced are given in percentages of the entire production of Great Britain. A sufficient number of years during the present century has been selected to show the nature of the alterations in question.

TABLE I.

PART I.	1806.	1823.	1830.	1839.	1847.	1852.
Total make of pig iron for the year	Tons. 258,200	Tons. 458,150	Tons. 698,900	Tons. 1,243,680	Tons. 1,999,600	Tons. 2,701,000
Average make per furnace per week *	30	34	50	64	90	123
Wales and Monmouthshire	31·03	42·93	44·59	38·80	36·16	25·77
Staffordshire	19·16	29·36	31·34	28·99	19·30	30·18
Shropshire	21·30	12·73	10·82	6·46	4·42	4·44
Scotland	9·00	5·38	5·52	15·70	26·99	28·69
Yorkshire—West Riding	10·33	6·00	4·27	4·20	3·38	2·22
Derbyshire	4·00	3·08	2·66	2·73	4·76	3·33
Cumberland and Lancashire	0·54	...	...	...	...	...
Northumberland, Durham, and North Riding, Yorkshire	...	0·52	0·80	0·04	4·99	5·37
Lincolnshire and Northamptonshire	...	...	...	...	...	...
Sundries	3·64	...	...	2·08	...	...
	100·00	100·00	100·00	100·00	100·00	100·00

PART II.	1855.	1860.	1865.	1870.	1875.	1880.	1884.
Total make of pig iron for the year	Tons. 3,218,180	Tons. 3,826,750	Tons. 4,819,250	Tons. 5,963,510	Tons. 6,365,460	Tons. 7,749,230	Tons. 7,811,720
Average make per furnace per week	103	126	146	173	194	263	261
Wales and Monmouthshire	27·12	26·63	19·00	17·15	9·39	12·23	11·34
Staffordshire	26·63	16·11	18·62	14·97	11·28	7·87	7·37
Shropshire	3·78	3·79	2·41	1·81	1·90	1·14	0·68
Scotland	25·74	24·50	24·13	20·25	16·50	13·53	12·65
Yorkshire—West Riding	2·82	2·58	2·56	1·38	4·19	3·96	3·18
Derbyshire	3·62	3·28	3·92	3·01	4·17	4·73	4·60
Cumberland and Lancashire	0·51	4·42	6·48	11·31	16·41	19·88	19·98
Northumberland, Durham, and North Riding	9·18	17·22	20·99	27·31	32·20	31·19	32·08
Lincolnshire and Northamptonshire	...	0·19	0·53	1·25	3·02	4·99	5·83
Sundries	0·60	1·28	1·36	1·56	0·94	0·48	2·29
	100·00	100·00	100·00	100·00	100·00	100·00	100·00
Furnaces in blast	599	582	657	664	629	567	575
Furnaces out	107	290	262	259	330	357	333
Total furnaces	706	872	919	923	959	924	908
Cwts. of coal per ton of iron, per Govt. returns	...	...	...	...	49·16	43·05	41·16

* The make per furnace in this table—1806 to 1852—is calculated on the total number of furnaces built, there being no record of those actually at work. In the subsequent period the make is given per furnace in blast. The figures for the first period are based on data taken from Scrivenor's work on the Iron Trade; those in the second are compiled from the Government returns.

The information contained in the table just given affords no data by which the mineral resources of the various districts can be judged. In some cases, as in South Wales, iron ore is very scarce and very expensive, and in consequence the works in that locality have practically always been dependent on other districts for a very considerable portion of their supplies. In Lincolnshire and Northamptonshire the ironstone is obtained very cheaply, which enables these districts to furnish, out of their abundance, after supplying the needs of their own furnaces, large quantities to works situated in Staffordshire, Derbyshire, &c. Cumberland and Lancashire formerly were the chief sources from which the deficiencies of South Wales were made good, but since the demand for steel has increased so largely, and owing to the erection of furnaces in these two counties, Wales now obtains its supply from foreign countries. The Cleveland furnaces, on the other hand, are placed near a mineral field with inexhaustible resources, and their position in respect to the Durham coal-field enables their owners to smelt imported ores upon conditions which make it possible for them to compete with the furnaces of Cumberland, Lancashire, and South Wales.

With a view of exhibiting the relative position of the various iron-making centres during the last thirty years, I have (see Table II.) taken, as a rule, every fifth year, and thereunder the weights of ore raised are given, together with the quantity of iron such ore is calculated to produce. By referring to the pig actually made in each locality, the extent to which ore, judged by its equivalent in iron, has been sent away to other places, or brought to the furnaces on the spot from a distance, is ascertained. The cinders mentioned as having been delivered to the blast-furnaces, represent the iron oxidised in the forges and mills during the conversion of the pig into malleable iron.

Table II.

	1855.	1860.	1865.	1870.	1875.	1880.	1884.
North-Eastern District*—	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Ore raised	1,155,300	1,483,800	2,882,300	4,297,000	6,182,000	6,528,000	6,103,800
Equivalent of pig in this ore at 30 per cent.	346,590	445,140	864,700	1,289,100	1,854,600	1,958,400	1,831,140
Smelted from other ore and cinders	...	213,460	147,700	338,400	194,700	458,000	673,760
Total make of district	**298,500†**	**658,600**	**1,012,400**	**1,627,500**	**2,049,300**	**2,416,400**	**2,504,900**
Scotland—							
Ore raised	2,400,000	2,150,000	1,470,000	3,500,000	2,452,000	2,664,400	1,885,400
Equivalent of pig in this ore at 32½ per cent.	780,000	698,750	477,750	1,137,500	796,900	865,930	603,320
Smelted from other ore and cinders	47,500	238,250	685,650‡	68,500	253,100	183,070	384,680
Total make of district	**827,500**	**937,000**	**1,163,400**	**1,206,000**	**1,050,000**	**1,049,000**	**988,000**
Wales and Monmouthshire—							
Ore raised	1,665,500	715,800	485,000	619,000	538,000	387,000	95,000
Equivalent of pig in this ore at 30 per cent.	499,650	214,740	145,500	185,700	161,400	116,100	28,500
Smelted from other ore and cinders	371,840	793,640	771,400	836,100	435,500	831,400	857,300
Total make of district	**871,490**	**1,018,380**	**916,900**	**1,021,800**	**596,900**	**947,500**	**885,800**
Staffordshire—							
Ore raised	2,500,000	1,523,000	1,484,900	1,360,000	1,654,400	1,761,400	1,873,700
Equivalent of pig in this ore at 34 per cent.	850,000	517,820	504,860	462,400	562,490	598,870	637,050
Smelted from other ores and cinders	5,500	98,630	394,030	429,400	149,310	10,630	...
„ elsewhere	...	...	...	...	...	...	61,150
Total make of district	**855,500**	**616,450**	**898,890**	**891,800**	**711,800**	**609,500**	**575,900**

* Includes Cleveland, Northumberland, and Durham.

† The difference here probably represents stock of ore on hand, the district in 1855 being a new one.

‡ No explanation is given in the Government Returns for the necessity of this large quantity of iron got from other than local ore.

TABLE II. (*continued*).

	1855.	1860.	1865.	1870.	1875.	1880.	1884.
Cumberland and Lancashire—	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Ore raised	537,616	989,600	1,504,500	2,092,000	1,983,000	2,759,400	2,595,300
Equivalent of pig in this ore at 55 per cent.	295,680	544,280	827,470	1,150,600	1,090,650	1,517,670	1,427,410
Smelted from other ore	...	...	...	...	...	23,530	34,590
„ elsewhere	279,110	375,080	515,060	472,800	45,850	...	...
Total make of district	**16,570**	**169,200**	**312,410**	**677,800**	**1,044,800**	**1,541,200**	**1,561,000**
Lincolnshire and Northamptonshire—							
Ore raised	74,000	112,500	489,300	1,009,000	1,659,800	2,704,600	2,628,600
Equivalent of pig in this ore at 33 per cent.	24,420	37,120	161,470	332,970	547,730	892,510	867,430
Smelted elsewhere	24,420	29,530	135,750	258,270	355,530	506,110	411,930
Total make of district	**nil**	**7,590**	**25,720**	**74,700**	**192,200**	**386,400**	**455,500**
Derbyshire—							
Ore raised	409,500	375,500	350,000	384,000	218,000	150,201	19,300
Equivalent of pig in this ore at 30 per cent.	122,850	112,650	105,000	115,200	65,400	45,060	5,790
Smelted from other ore and cinders	...	13,200	84,360	64,500	206,600	321,640	353,510
„ elsewhere or stocked	6,300	...	...	...	...	..	...
Total make of district	**116,550**	**125,850**	**189,360**	**179,700**	**272,000**	**366,700**	**359,300**
Shropshire—							
Ore raised	365,000	165,000	273,800	337,000	240,500	226,700	198,800
Equivalent of pig in this ore at 33 per cent.	120,450	54,450	90,350	111,210	79,360	74,810	65,600
Smelted from other ores and cinders	1,230	90,750	26,990	1,090	41,630	13,520	...
„ elsewhere or stocked	...	...	...	...	...	...	12,380
Total make of district	**121,680**	**145,200**	**117,340**	**112,300**	**120,990**	**88,330**	**53,220**

TABLE II. (*continued*).

	1855.	1860.	1865.	1870.	1875.	1880.	1884.
Yorkshire, West Riding—							
Ore raised	Tons. 255,000	Tons. 255,700	Tons. 575,000	Tons. 307,000	Tons. 353,600	Tons. 286,600	Tons. 167,800
Equivalent of pig in this ore at 30 per cent.	76,500	76,710	172,500	92,100	106,080	85,980	50,340
Smelted from other ores and cinders	14,340	21,390	...	...	161,020	220,520	197,960
„ elsewhere or stocked	...	...	49,270	14,400	...	...	...
Total make of district	**90,840**	**98,100**	**123,230**	**77,700**	**267,100**	**306,500**	**248,300**
Sundry places, including Ireland—							
Ore raised	190,740	252,200	393,300	464,400	509,700	557,700	570,300
Equivalent of pig in this ore at 36 per cent.	68,660	90,790	141,580	167,180	183,490	200,770	205,300
Smelted elsewhere	49,160	40,500	76,110	73,580	123,680	163,420	26,010
Total make of the districts	**19,500**	**50,290**	**65,470**	**93,600**	**59,810**	**37,350**	**179,290**
Imported ores from foreign countries—							
Received, including "Blue Billy," from cupreous pyrites.	...	23,110	...	208,300	738,000	3,060,300	3,153,000
Equivalent of pig in this ore at 52 per cent.	{ None in Govt. returns. }	12,010	{ None in Govt. returns. }	108,310	383,760	1,591,350	1,639,560
Smelted in different places, chiefly South Wales, north-eastern district, and Scotland	...	12,010	...	108,310	383,760	1,591,350	1,639,560

In order to check the yield of ironstone in metal with the actual weight of pig iron produced, the weights of the former have been extracted from the Government returns for ten years, beginning in 1860.

The total quantity of iron ore worked and imported was 93,792,000, and the pig iron, by the assumed percentage contained in the ores, amounts to 33,133,000 tons.

The weight of pig iron for the ten years, as given in the Mineral Statistics, is 45,434,000 tons, or 12,301,000 in excess of the quantities supposed to be contained in the ores. If, during the period just mentioned, there were made 13,550,000 tons of malleable iron, and if, moreover, it is assumed that there would be carried off in cinder which is returned to the blast furnace 4½ cwts. of iron for each ton of malleable iron produced, a quantity of iron equal to 3,048,750 tons of pig is accounted for beyond the 33,133,000 tons. There still remains unaccounted for 9,252,250 tons over the decade.

The average yield of the ores, without counting the cinder used, over the ten years, was 48½ per cent. It looks, *prima facie*, as if above 20 millions of tons of ore had been raised in excess of the quantity given in the Mineral Statistics, or as if the weight of pig iron made had been considerably over-stated.*

In later years the returns appear to have been more correctly made; for, although a much larger proportion of richer ore has been used, the yield in pig works out over the years 1882, 1883, and 1884, to only 40¼ per cent. instead of 48½, as in the ten years above referred to.

In the last three years we have the advantage of knowing approximately the quantity of malleable iron manufactured. The ore, including the imports, available for the blast furnaces was 61,941,000 tons, and capable of producing 22,250,000 tons of pig iron. The malleable iron made was 7,000,000 tons, giving an amount of cinder, on the basis previously taken, which would be equivalent to 1,575,000 tons of pig.

* It is necessary, however, to bear in mind that Mr. Hunt has pointed out that returns of the ore raised were not in all cases obtainable, and, further, that he did not always find it possible to distinguish the calcined from the uncalcined ore, which might somewhat materially have increased the quantity given as raw ore.

The pig iron produced, according to the Government returns for the three years, was 24,927,000 tons; whereas the ore, as we have seen, was equal to 22,250,000 tons. This, added to 1,575,000 tons contained in the cinder, gives 23,825,000 tons, which is a close approximation to the quantity actually given as made, viz., 24,927,000 tons.

It may be worthy of the attention of Her Majesty's Commissioners whether, in the interests and convenience of the manufacturers themselves, as well as on account of national considerations, proper returns should not be made obligatory on ironmasters, the same as is now the case in regard to the mine-owners, and then put in such a form as would be found best suited to afford all the information required by those interested in the subject.

Among the events which have operated in establishing and developing the manufacture of pig iron is the order in which the discoveries of ore have occurred. If, for example, the vast and cheaply wrought deposits of North Yorkshire, Lincolnshire, and Northamptonshire had been known prior to the erection of ironworks in South Wales and Staffordshire, it is highly improbable that either of the latter would have attained the important position as centres of the trade indicated by the figures recently quoted in these pages. South Staffordshire affords a remarkable instance of the change effected by the opening out of one of the iron fields just named. In 1858 there was raised in this old seat of the trade 959,000 tons of ironstone, and the pig iron produced was 597,800 tons. In 1884 the make fell to 279,300 tons, and of it 80 per cent. was obtained from ironstone brought from Northamptonshire.

The circumstances referred to in the previous paragraph have contributed largely to reductions in the price of pig iron. Previous to 1850, or rather later, the foundries and rolling-mills on the Tyne, Wear, and Tees were large consumers of Scotch iron. As the Cleveland stone gained ground, the ironmasters in Scotland lost their customers in this north-eastern district of England, and ultimately the current of the trade

was reversed, so that for some time past the Cleveland makers have often been sending about 1000 tons of metal a day into Scotland.*

Of the pig iron manufactured in the United Kingdom a very large proportion is converted into one or other of the two malleable forms of the metal. This in recent years has varied from 50 to 55 per cent. of the entire make.

By the system known as the puddling process, invented by Henry Cort, just about 100 years ago, almost any description of pig was capable of being converted into malleable iron; but when the separation of the foreign matter taken up by the metal in smelting was attempted in the Bessemer converter, or in the open-hearth furnace, to form steel, no pig containing above one part of phosphorus in one thousand of iron was found fit for the purpose.

Although fully one half the iron required in the malleable form continues to be made in the puddling furnace, the remainder, treated by the more modern processes known as the Bessemer and Open-hearth, is so great as to have at one time entirely altered the relative values of the two kinds of ore in the manner referred to at page 4. In 1870, fifteen years after Bessemer's invention, the quantity of steel ingots made in the United Kingdom, including 25,000 tons produced in the open-hearth, was 240,000 tons. In 1882 the weight of the two was 2,110,000 tons, of which 436,000 tons were made in the open-hearth furnace. In the former year the pig iron made from native hæmatite ore was 677,800 tons against 108,300 tons from

* The following table shows the quantities of Cleveland and hematite pig iron imported into Scotland :—

Year.	Cleveland.	Hematite.	Total.
1877	302,000	51,000	353,000
1878	289,000	36,000	325,000
1879	261,000	54,000	315,000
1880	283,000	52,000	335,000
1881	313,000	107,000	420,000
1882	238,000	107,000	345,000
1883	273,000	159,000	432,000
1884	277,000	92,000	369,000

foreign ore, in the latter year the quantities were 1,792,000 and 1,919,840 tons respectively. To illustrate the effect on the value of the two kinds of pig iron—hæmatite for steel and Cleveland for puddling—the prices of both are given for the years beginning at 1870 down to the end of 1884.

	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.
Hæmatite,	72/3	89/6	170/0	156/9	108/6	78/3	66/10	64/6	60/6	59/4	81/6	59/0	56/7	49/11	44/11
Cleveland,	50/3	49/8	97/1	109/2	70/11	54/6	47/10	42/1	39/1	37/4	45/0	39/2	43/5	39/5	37/0
Difference,	22/0	39/10	72/11	47/7	37/7	23/9	19/0	22/5	21/5	22/0	36/6	19 10	13/2	10/6	7/11

The present selling prices (Nov. 1885) are about 42s. 6d. for hæmatite, and 32s. for the puddling iron of Cleveland.

Great as the advantages of steel are as compared with iron, it is quite certain that unless this country had been able to import foreign ore at a cheap rate, its use would have been greatly retarded by the want of the suitable raw material required for its manufacture. As a matter of public convenience this would have been a serious loss, because, besides greater durability of the product, the Bessemer process has the merit of extraordinary simplicity and economy. The crude iron may be, and generally is, run from the blast-furnace into the converter, and before it has lost much of its fluidity compressed air is driven through it. The chemical action by this mode of treatment is so energetic that an ingot of steel is obtained sufficiently hot to be capable, in many cases, of being rolled direct into a finished bar. Put in another way, the heat evolved in smelting the ore suffices to carry the transformed metal through the rolling-mill so cheaply, that it is calculated that ore can be brought from Bilbao and converted into steel rails at Middlesbrough at the same or even a less cost than the same article can be made of iron from the ironstone of the Cleveland hills, lying almost at the gates of the rail-mills.

With this fact before us it may well be asked whether the other half of the metal still continued to be rendered malleable by puddling, may not also be superseded by ingots obtained

from the converter. This is a question which has not yet been settled by the consumer. For such purposes as do not require much heating and fashioning before being brought into use, steel undoubtedly possesses, on account of its superior strength and durability, many advantages over ordinary welded iron. Rails furnish such an instance as that referred to, and in consequence, for this purpose, the use of the latter material may be regarded as abandoned.

No attempt to ascertain the make of malleable iron in the United Kingdom was made until the year 1881, and even then I am not aware of there being any record of the various classes which were rolled. Certain firms in the north-eastern district of England, however, constituting about nine-tenths of the makers there, for trade purposes acted differently, and their experience may probably serve as a fair representation of this branch of the iron manufacture elsewhere.* In the year 1873 the houses in question produced 324,440 tons of iron rails, 79,426 tons of bars, and 209,996 of plates and angles—in all 613,862 tons.† The average annual make for the three years

* The make of this part of the kingdom is about one-fourth of that of Great Britain.

† To show the gradual decline in the manufacture of iron rails in the district referred to, the annual make is given, along with its total production of malleable iron :—

Year.	Rails.	Bars.	Plates.	Angles.	Total.	Cleveland Ore raised.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
1872	299,075	75,154	177,857	58,167	610,253	4,974,000
1873	324,440	79,426	165,593	44,403	613,862	5,617,000
1874	265,020	91,053	178,272	49,501	583,846	5,614,000
1875	246,218	101,641	173,417	41,246	562,522	6,121,000
1876	107,832	88,304	172,374	52,665	421,175	6,562,000
1877	36,750	77,132	214,723	67,035	395,640	6,284,000
1878	21,646	78,283	233,964	87,651	421,544	5,605,000
1879	6,769	60,848	173,700	48,892	290,209	4,750,000
1880	27,417	71,399	316,722	92,899	508,437	6,486,000
1881	15,904	70,490	391,468	120,557	598,419	6,538,000
1882	5,601	62,570	433,216	129,647	631,043	6,326,000
1883	2,904	80,933	440,157	133,606	657,600	6,756,000
1884	3,516	81,578	270,910	72,282	428,286	6,052,000

The increase in the years 1880 and 1881 was due, if I remember rightly, to orders for exportation to countries where the duty on steel rails was considerably higher than on those of iron.

ending 1884 was 4010 tons of rails, 75,027 tons of bars, and 493,275 tons of plates and angles, together 572,312 tons. This shows a decrease of 41,550 tons as compared with the year 1873.

The weight of Cleveland ironstone raised in the thirteen years is given in the footnote, p. 18. The average of the last three years (1882, 1883, and 1884) shows an increase of 20 per cent. on that of 1872 and 1873, whereas the malleable iron made exhibits a falling off of 6 or 7 per cent. in the last years as compared with the first. These figures indicate the probability of the demand for Cleveland iron for foundry purposes having considerably increased, while that for forge purposes has diminished.

On referring to the table in the footnote it will be seen, that had it not been for the great demand for plates and angles, mostly for shipbuilding, the loss of ground in the production of malleable iron would have been very much more alarming than was the case. The average quantity of these two descriptions of iron produced was 224,010 tons in 1872 and 1873 against 549,550 tons in the three years ending 1883, but at the present moment the same fate which happened in the case of iron rails threatens to overtake iron plates and angles for shipbuilding. If this occurs it may mean an annual withdrawal of custom from the Cleveland or other analogous mines of about $2\frac{1}{4}$ million tons of ironstone and the importation of its equivalent of Spanish or other foreign ore. This substitution will continue so long as the difference of price between the two kinds of ore is represented by anything under 8s. or 10s. on the ton of pig iron, this being the extra cost assumed as that incurred by the "Basic Process."

It may be convenient at this point to consider a little further the progress of the new branches of industry—Bessemer and Open-hearth steel—which have effected so great a revolution in the history of the iron trade.

In the absence of any information respecting the make of malleable iron before 1880, I have been compelled to accept the number of puddling-furnaces as given in the Government Mineral Statistics to illustrate its progress and decline. This

for the year 1860 is stated to be 3,462, capable of making, were they all in operation, which is generally far from being the case, about 2 million tons of puddled iron.

It was something like ten years after Bessemer had described his process before the British Association at Cheltenham in 1856 that his system began to deserve the name of a recognised branch of industry, and this only after failure had attended some attempts to introduce it.

So late as the year 1864 the cost of making railway bars from steel was so high that when ordinary iron rails were being sold at £7. per ton, those obtained by the aid of the Bessemer converter were charged £17. 10s. During that year the mean selling-price of Cleveland pig iron was £2. 17s., and of hæmatite pig a little under £4., being a difference between the crude metal and the finished rail of £4. 3s. for the iron, and about £13. 10s. for the steel. At this period, and even much later, the malleable iron manufacturers evidently saw nothing to indicate the formidable character of the rival which was growing up in their very midst. This is inferred from the fact that between the years 1860 and 1875 the number of puddling-furnaces had been increased from 3,462 to 7,575, or about 119 per cent.* This latter number represents a capacity of about 4½ million tons of puddled iron, or, allowing for those idle for repairs, probably 4 millions of tons. It would seem, however, that included in these 7,575 furnaces must have been some at old works which may have been regarded as abandoned, for it is more than doubtful that the weight of puddled iron ever reached so high a figure as 4 million tons; probably 3 millions would be nearer the mark.

In the meantime, in 1870, when the total weight of ingots was only 240,000 tons, steel rails had fallen to £10. per ton, those of iron being quoted at £7., the difference between these prices and hæmatite and Cleveland pig being £6. 8s. and

* Number of puddling-furnaces in existence in the years

	1860.	1865.	1870.	1875.	1880.	1884.
Furnaces . . .	3462	6407	6699	7575	5134	4577

as given in the Government returns of 1884.

£4. 10s. respectively. At present it would be impossible to say what the price of iron rails in large quantities would be, the article having practically disappeared from the market; but, as regards those of steel, they have been currently sold at rates which only left a difference of 40s. to 50s. above the price of hæmatite pig iron, the make of steel ingots on a dozen years having increased nearly ninefold. The table No. III. given below contains information which is interesting as showing the effect of the change from iron to steel, beginning at the year 1870. It gives the weight of steel ingots made in the United Kingdom, and the quantity of hæmatite pig required for their production. The remainder of this kind of pig was exported for foreign steel makers or consumed in our own foundries, and a certain portion of the ore itself was used for admixture in the blast furnaces producing other than purely hæmatite pig, or employed as fettling in the puddling process :—

TABLE III.

Weights of Steel Ingots, with Quantities of Hæmatite Pig used and made, and Prices of Cleveland and Hæmatite Pig (1 = 1000).

Year.	Ingots, including Open Hearth.	Pig Required for Ingots.	Equivalent of Pig in :—		Total.	Average Prices per Ton.	
			British Ore.	Foreign Ore.		Cleveland Pig for Iron Rails.	Hæmatite Pig for Steel Rails.
	Tons.	Tons.	Tons.	Tons.	Tons.	£. s. d.	£. s. d.
1870	240	264	1151	108	1259	2 10 3	3 12 3
1871	357	393	1228	272	1500	2 9 8	4 9 6
1872	450	495	972	547	1519	4 17 1	8 10 0
1873	573	630	1185	645	1830	5 9 2	7 16 0
1874	630	693	1118	524	1642	3 10 11	5 8 6
1875	708	779	1090	383	1473	2 14 6	3 18 3
1876	828	911	1285	505	1790	2 7 10	3 6 10
1877	887	976	1289	809	2098	2 2 1	3 4 6
1878	958	1054	1159	817	1976	1 19 1	3 0 6
1879	1009	1110	1162	736	1898	1 17 4	2 19 4
1880	1291	1420	1551	1591	3142	2 5 0	4 1 6
1881	1780	1958	1617	1457	3074	1 19 2	2 19 0
1882	2110	2321	1792	1919	3711	2 3 5	2 16 7
1883	2008	2209	1673	1862	3535	1 19 5	2 9 11
1884	1760	1936	1561	1639	3200	1 17 0	2 4 11

In the estimates just previously given, the quantities of hæmatite pig produced are on the assumed yield of the ore

raised; but for some years after 1870, a very large proportion of the ore was employed in South Wales and elsewhere as a mixture with local ironstone for making bar iron. In 1870 the actual make of pig in Lancashire and Cumberland was 677,800 tons, of which 264,000 tons was calculated to have been used in British steelworks.* The remainder (413,800 tons) would be employed for foundry purposes or exported for steel making, &c. This left ore representing 472,800 tons of pig iron (Table II., page 12) to be used as an admixture with other ores, an object which, it will be seen, disappeared in respect to the produce of the Cumberland and Lancashire mines in the last two years given.

The effect of the large increase in the quantity of steel produced in the United Kingdom was of course followed by a diminution in the make of malleable iron, as is evidenced by only 5,134 puddling-furnaces returned as being in existence in 1880, a number which was further reduced to 4,577 in 1884. In further illustration of the distress which overtook this branch of the trade, it is stated by Mr. Jeans in his report to the British Iron Trade Association, that malleable iron works, representing a million and a half of money, were lying idle in the year 1877 in the north-eastern district of England alone.

The quantity of puddled iron made during the last four years, according to the returns in the Report of the British Iron Trade Association, is as follows :—

	1881.	1882.	1883.	1884.
Tons . .	2,681,150	2,841,534	2,730,504	2,237,504

Largely as the make of hæmatite pig made from British ore has been supplemented by that smelted from imported mineral, the demand for this quality of iron, for home consumption and exportation, occasionally exceeded the supply to such an extent that the price rose considerably. At one period, the year 1879, the price of hæmatite pig was only 10s. 6d. per ton above that of Cleveland, but during the same year the difference rose to 52s. 6d. In 1880 the difference

* At that time practically most of the pig iron used for steel-making was got *from these two counties.*

averaged 36s. 6d., and it would have been much more marked had the imports of Spanish ore in the latter year not been doubled, and had the output of the British mines not been also greatly increased (*vide* Table II., p. 12). Enormous as the resources of Bilbao are in its ore deposits, it may be open to question whether, if all the plates and angles now made of iron were required of steel, these resources would prove equal to the demands they would be called upon to meet. Further on the consumption of iron for shipbuilding will be given, in which steel will be included. In the meantime the following figures will show how rapidly the latter is gaining ground for naval purposes.

Tonnage of Vessels built of Steel.

	1877.	1878.	1879.	1880.	1881.	1882.	1883.*	1884.†
Gross Tonnage.	1,118	9,516	21,222	38,164	71,533	135,086	125,841	151,339

In addition to the substitution of steel for iron in shipbuilding, the use of the former is extending in other directions, of which tin plates and wire afford striking examples. When it is considered that about 349,000 tons of the former were made in Great Britain in 1884, and that the latter is a rapidly increasing trade, it is clear that these two items alone present a considerable field for an increased application of steel.

As regards wire, for which steel is admirably adapted, the make for fencing and other purposes has greatly increased in late years. The Germans turned out 179,000 tons in 1878, which rose to 378,000 in 1882. Of this last quantity 145,000 tons were of steel. I have no account of the make in Great Britain, but it looks as if half a million tons a year at least is the total annual production of this one article. Not the least important advantage of Bessemer steel over iron lies in its greater economy of manufacture. To make railway bars of this material the waste of metal is about one-half, while the wages and fuel for the conversion are only about one-third, of what is required for iron.

* Shipbuilding fell off greatly in 1884. The figure given is only for vessels classified in Lloyd's and Liverpool, Bureau Veritas not being included.

† This number only includes classified vessels. Besides these there might be a few unclassified ships built of steel.

This extended consumption of steel, not only in this country, but on the continent of Europe and in the United States, both of which latter also import Bilbao ore, might inspire some apprehension as to the supply of the pig iron required for its production. The basic process, incidentally mentioned on a previous page, relieves us from all difficulty on this score. By means of linings made of dolomitic limestone in the converters or open-hearth furnaces, and by the use of lime in the operation itself to neutralise the silica produced in the process, pig iron containing any amount of phosphorus, usually found in the metal, can be safely used. This mode of treatment is attended with some additional expense, but as this does not exceed the usual difference between the cost of producing hæmatite and Cleveland iron, the world need not fear that its demand for steel runs any danger of being limited by the want of the necessary raw material. In order to show the extent to which the basic system has been applied for the dephosphorisation of Cleveland and other iron, I have obtained from Mr. Gilchrist, one of the patentees of the process, the following particulars of what has been done in England and other countries up to September 1885:—

TABLE IV.

	England.	Other Countries.	Total.
1878	20	...	20
1879	1,150	50	1,200
1880	10,000	40,000	50,000
1881	46,120	289,880	336,000
1882	109,364	340,636	450,000
1883	122,380	511,993	634,373
1884	179,000	685,000	864,000
To September 1885 .	145,707	799,610	945,317
Total . . .	613,741	2,667,169	3,280,910

Whether the Basic process is capable of furnishing steel suitable for all the purposes to which this material is applied, experience alone can show. In the meantime it may be observed that by it a product has been obtained equal in purity to the best

steel got by the ordinary Bessemer process from English or Spanish hæmatite ore; and, further, that for railway tyres and boiler plates the Basic process has been largely and successfully used in Germany and elsewhere.

From what has preceded in reference to the production of pig iron, it may be inferred that not only has excessive competition between old and new seats of the iron trade been engendered by the discovery and speedy development of cheaply worked beds of ironstone, but that the change from wrought iron to steel has caused the partial or entire abandonment of one class of mineral and the adoption of another suitable for the Bessemer or Open-hearth processes. South Wales offers a remarkable instance of an almost complete revolution in the character of its iron industry. Twenty years ago or thereabouts, about one million tons of pig iron were annually converted into malleable iron—to-day the puddling process of Cort, after a reign of about a century, is almost a thing of the past. The old ironworks are now engaged in the manufacture of steel, and hence, in describing that of pig iron, I have been compelled to enter at some little length into its conversion into the secondary products.

I will now proceed to consider the manner in which the metal so obtained is disposed of. The table which follows gives the pig iron made, from which is deducted the quantity exported, or that required for the manufacture of articles exported in the form of rails, machinery, &c. The difference between the two sets of figures represents, but only approximately, the weight of pig iron actually required for producing the castings, wrought iron and steel in their various forms used in the United Kingdom. It commences with the year 1870, because this suffices to exhibit the more important changes of relative position between this country and other nations in an iron-making point of view. Following the quantity of pig iron made in each year, the prices of Cleveland pig iron are inserted so as to judge of the state of the market. The figures, including also the Stocks on hand, are given in thousands of tons.

TABLE V. (1 = 1000).

Exports.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.
As pig	Tons. 753	Tons. 1057	Tons. 1331	Tons. 1142	Tons. 776	Tons. 947	Tons. 910	Tons. 882	Tons. 923	Tons. 1223	Tons. 1632	Tons. 1482	Tons. 1758	Tons. 1564	Tons. 1269
In various other forms. exclusive of machinery, reduced to pig .	2590	2640	2563	2268	2139	1887	1642	1830	1716	2075	2700	2922	3244	3099	2785
Total exports, exclusive of machinery, considered as pig	3343	3697	3894	3410	2915	2834	2552	2712	2639	3298	4332	4404	5002	4663	4054
Home consumption, including that for machinery exported .	2620	2930	2847	3156	3076	3531	4003	3896	3742	2697	3417	3740	3584	3866	3757
Total Production of United Kingdom. . .	**5963**	**6627**	**6741**	**6566**	**5991**	**6365**	**6555**	**6608**	**6381**	**5995**	**7749**	**8144**	**8586**	**8529**	**7811**
Prices of Cleveland pig . . .	**50/3**	**49/8**	**97/1**	**109/2**	**70/11**	**54/6**	**47/10**	**42/1**	**39/1**	**37/4**	**45/**	**39/2**	**43/5**	**39/5**	**37/**
Stocks of pig (Scotch) . . .	**665**	**490**	**194**	**120**	**96**	**170**	**363**	**505**	**679**	**745**	**739**	**940**	**836**	**835**	**821**
Cleveland	117	68	41	80	90	74	182	274	337	283	331	378	266	253	339
Cumberlandshire and Lancashire	390	280	117	100	92	121	262	383	433	466	150	126	109	244	249
Other kinds											321	292	365	337	400
Total Stocks	**1172**	**838**	**352**	**300**	**278**	**365**	**807**	**1162**	**1449**	**1494**	**1541**	**1736**	**1576**	**1669**	**1809**

Cumberland, Lancashire, and other kinds are mere estimates up to 1879. The same remark applies to Scotland for the year 1879.

Included in the iron entered for home consumption is a considerable quantity of machinery, for which the value and no weight is given. This consists of articles of very different prices, about one-third being steam-engines. The total values are given below, and assuming their average price equal to £30. per ton, we have the weights—calculated on this basis—in the third column. To cover waste in conversion and manufacturing, the equivalent in pig iron is taken at 30 cwt. per ton of machinery exported, and the result will be found in the last column. The price per ton, no doubt, varies in different years, but as the estimate is a very rough approximation, the value is taken at the same throughout:—

TABLE VI.

Year.	Value.	Weight.	Equivalent in Pig Iron.
	£.	Tons.	Tons.
1870	5,293,273	176,440	264,660
1871	5,966,041	198,868	298,302
1872	8,201,112	273,370	410,055
1873	10,019,929	333,998	500,996
1874	9,790,914	326,324	489,486
1875	9,058,647	301,955	452,932
1876	7,210,426	204,048	306,072
1877	6,722,868	224,096	336,144
1878	7,497,959	249,932	374,898
1879	7,279,205	242,610	363,915
1880	9,263,516	308,783	463,174
1881	9,960,210	332,007	498,010
1882	11,932,247	397,741	596,611
1883	13,433,081	447,773	671,660
1884	13,073,464	435,782	653,673

These figures justify the assertion that the engine and machine builders are very important customers of our iron-works, for it must be recollected that in addition to the articles they export there is a large weight of iron required for machinery to be used in the United Kingdom.

The figures given in Table V., as showing the consumption of pig iron in the United Kingdom, require correction so as to allow for the assumed weight of machinery exported, and for the differences of stocks of metal on hand. These are given in Table VII., and following it is VII. (A), containing the consumption by foreign nations.

TABLE VII. (1 = 1000).

Exports.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.
Tons carried from Table V., page 26	2620	2930	2847	3156	3076	3531	4003	3896	3742	2697	3417	3740	3584	3866	3757
,, Stocks—add (decrease) ,,	...	334	486	52	22	...	...	...	...	...	...	...	160	...	...
,, ,, deduct (increase) ,,	...	...	...	...	...	87	442	355	287	45	47	195	...	93	140
	2620	3264	3333	3208	3098	3444	3561	3541	3455	2652	3370	3545	3744	3773	3617
,, machinery exported reduced to pig iron to deduct, *vide* p. 27	265	298	410	501	489	452	306	336	375	364	463	498	596	672	654
	2355	2966	2923	2707	2609	2992	3255	3205	3080	2288	2907	3047	3148	3101	2963
Imports reduced to pig . . .	136	128	160	140	168	198	206	235	277	277	367	381	415	421	400
Nett consumption in U. Kingdom .	2491	3094	3083	2847	2777	3190	3461	3440	3357	2565	3274	3428	3563	3522	3363

TABLE VII. (A).—*Consumption by Foreign Nations of Pig Bars, &c., reduced to Pig.*

Exports.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.
Exported from Great Britain . .	3343	3697	3894	3410	2913	2834	2552	2712	2639	3298	4332	4404	5002	4663	4054
,, ,, as machinery	265	298	410	501	489	452	306	336	375	364	463	498	596	672	654
Total—Reduced to pig received from Great Britain . .	3608	3995	4304	3911	3402	3286	2858	3048	3014	3662	4795	4902	5598	5335	4708
Less imported into Great Britain from other nations . .	136	128	160	140	168	198	206	235	277	277	367	381	415	421	400
Nett received from United Kingdom by foreign nations .	3472	3867	4144	3770	3234	3088	2652	2813	2737	3385	4428	4521	5183	4914	4308
Make of foreign nations . .	5602	5837	7604	8123	7530	7268	6884	7237	7710	8053	10328	11133	12140	12534	12469
Total consumption by foreign nations	9074	9704	11748	11893	10764	10356	9536	10050	10447	11438	14756	15654	17323	17448	16777

It may be useful here to observe that the weights of pig iron assumed as the annual rates of consumption do not represent the actual weight of metal received by the consumers, for to the figures given above must be added a very large quantity of old metal and iron, probably exceeding one million tons per annum, which is sold to the founders and malleable iron makers to be remanufactured.

Doubtless, in the estimates in Table VII., there are assumptions sufficient to cause some modification in the figures it contains; but it is apprehended that there are reasonable grounds for inferring, from the information therein given as to the consumption in the United Kingdom, that the figures are not far from the truth.

On referring to the exports given in Table V. on page 26, it will be observed that they experienced no increase between 1871 and 1879. On the contrary there was a steady decrease, while on the other hand the make of pig iron may be regarded as stationary during these nine years.

To show the extreme fluctuations of prices before and after 1872 and 1873, the following quotations are given:—

TABLE VIII.

	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.
Cleveland pig.	50/3	49/8	97/1	109/2	70/11	54/6	47/10	42/1	39/1	37/4
Hæmatite pig.	72/3	89/6	170/	156/9	108/6	78/3	66/10	64/6	60/6	59/4
Staffordshire marked bars	£7.	£8.	£14.	£15.	£13.	£11.	£9/10/	£8/15/	£8.	£7/10/
Cleveland bars	£6/19/	£6/17/	£9.	£11/9/	£10/9/	£8.	£7/2/	£6/15/	£6/2/	£5/7/

The production of pig in 1872 and 1873 being nearly 6½ million tons, the stocks in these years would only represent about three weeks' make, which would barely at that time suffice to enable the ironmasters to supply their customers with the different qualities and numbers they required. Great pressure was put on the makers by new buyers, and still greater by those who

had previously contracted at less than 50s. per ton. This gave rise to great speculative purchases which drove the price up to about 110s.

The extravagant prices paid for Cleveland pig iron produced an immediate effect on the value of coke. Besides the blast-furnaces of the north-east of England, those in Lincolnshire, Cumberland, and Lancashire draw their supplies chiefly from the Durham coalfield. The following was the make of pig iron in these districts for the three years ending 1873:—

TABLE IX. (1 = 1000).

Year.	North-East of England.	Lancashire and Cumberland.	Lincolnshire.	Total.
	Tons.	Tons.	Tons.	Tons.
1871	1884	856	30	2770
1872	1968	964	37	2969
1873	2000	986	52	3038

These figures would indicate that the coke required in 1872 would exceed that consumed in 1871 by about 265,000 tons, and about 350,000 in 1873—not a large quantity for a district turning out annually $3\frac{1}{4}$ million tons. Notwithstanding this fact, coke rose until it reached the fabulous price of 40s., its present value (December 1885) being about 8s. 6d. at the ovens. This increased demand was supplemented by the colliers deciding to hew a smaller quantity of coal, which was the cause of 29,640,000 tons being worked in 1873 against 30,405,000 tons in 1872, or 765,000 tons less in the latter year than in the former. The effect on the price of coke in the county of Durham will be seen from the following average quotations at the coke-ovens, given me by one of the largest coke-makers in the North of England:—

1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.
10/1	10/6	16/	34/	26/	15/6	12/	11/	10/6	9/6	10/6	9/6	10/	10/6

Let us now endeavour to ascertain, so far as the statistics at our command will permit, the cause of the falling off in the

weight of pig iron needed in 1884 by the inhabitants of these islands. The first object to which one naturally turns is the rail trade, which not only in this country, but in all the great iron-making nations, is the largest single article of manufacture. The following figures show the quantities manufactured for the three years ending 1883, from which it is inferred that, including the countries not specified, the make of the world may be taken at 4 million tons or more :—

TABLE X.

		1881.	1882.	1883.
United Kingdom . .	Iron & steel	1,215,623	1,346,124	1,137,835
United States . . .	,,	1,646,518	1,507,851	1,214,906
Germany	,,	530,148	523,899	473,560
Belgium (1881 assumed) .	,,	130,000	134,875	131,635
France, Austro-Hungary, and Russia (estimated)	,,	608,000	700,000	759,000
		4,130,289	4,212,749	3,716,936

These quantities, showing a falling off of nearly 500,000 tons in 1883 as compared with 1881, embrace the rails required for constructing new lines as well as for renewals on railways already at work. It will be more convenient to consider these two applications separately, because when the rails are merely required for repairs, the old rails are returned to the manufacturers, and these must be allowed for in the plan adopted for any calculations.

A competent authority whom I have consulted on the subject calculates that each single line on the railways of the United Kingdom requires in its construction about 120 tons of rails, 70 tons of chairs, and 35 tons of iron in bridge-work, spikes, &c. Upon this basis, and reckoned upon the miles of railway annually constructed, according to the official returns, the quantities of these different articles laid down have been estimated as set forth in Table XI. which follows.

Each item has had its equivalent in pig iron worked out: rails (iron and steel) averaged at the rate of 25 cwts. for each ton,

chairs at 21 cwts. per ton, and the other ironwork, partly castings, to include waste in engineering work, is taken at 25 cwts. per ton. The average of the whole is estimated at 268 tons of pig iron per mile of single road.

TABLE XI.

Year.	Miles of Single Line including Sidings.	Rails.	Chairs.	Bridges, &c.	Equivalent in Pig Iron.
		Tons.	Tons.	Tons.	Tons.
1870 & 1871	683	81,960	47,810	23,905	183,044
1872	816	97,920	57,120	28,560	218,688
1873	590	70,800	41,300	20,650	158,120
1874	572	68,640	40,040	20,020	153,296
1875	478	57,360	33,460	16,730	128,104
1876	646	77,520	45,220	22,610	173,128
1877	362	43,440	25,340	12,670	97,016
1878	577	69,240	40,390	20,195	154,636
1879	829	99,480	58,030	29,015	222,172
1880	492	59,040	34,440	17,220	131,856
1881	316	37,920	22,120	11,060	84,688
1882	604	72,480	42,280	21,140	161,872
1883	247	29,640	17,290	8,645	66,196
1884	556	66,720	38,920	19,460	149,008

Great as the fluctuation has been in the demand for rails, &c., for new lines, the greatest extreme in the fifteen years just examined (1870 and 1884) does not present a difference much exceeding 150,000 tons, which is not of itself of such a magnitude as necessarily greatly to affect such an industry as the iron trade. It may be worthy of notice that since 1854 there were only three occasions when the new railroads constructed exceeded 1000 miles of single way, viz. in 1862, 1863, and 1866. The pig iron required for these lines was as follows:—

	1862.	1863.	1866.	Average for Fifteen Years, 1854 to 1869.
Miles of single road	1,034	1,376	1,030	806½
Tons of pig iron at 268 tons per mile .	277,112	368,758	276,040	216,142

The average of the fifteen years ending 1884, of which the details have been given, is $517\frac{3}{15}$ miles, equal therefore, at 268 tons of pig iron per mile, to 138,788 tons per annum over the whole period.*

* Some deductions ought to have been made for the lighter rails, &c., used in the first years, but I have retained the figures sent to me.

There are few questions of greater interest to railway companies and to iron manufacturers, and none upon which greater diversity of opinion prevails, than the comparative durability of iron and steel when exposed to the wear of heavy railroad traffic.

When it seemed probable that the old welded rails might have to give way to those rolled from a solid ingot, numerous calculations were put forth as to the comparative durability of the two materials. Owing to the peculiarities in the manufacture, the ordinary iron rails are apt to laminate or split off at the weldings of the separate bars which constitute the mass out of which they are rolled. At other times, owing to the softness of the material itself, the rail-head is crushed down by the great weight of the traffic passing over it. These defects were not removed when, by means of mechanical puddling, the rails were rolled out of one solid mass, because the process itself, separating the malleable metal in the form of granules, gives a product made up of an infinite number of welded particles, from which it is almost if not quite impossible to expel all traces of scoria generated during the process of manufacture.

The ingot of Bessemer steel, on the other hand, having been previously completely liquefied in the converter, an opportunity is afforded for an almost entire separation of scorious matter, by virtue of the great difference in the specific gravity between it and the molten metal. Rails made from a mass so nearly homogeneous are not liable to be broken up in the same manner as happens with iron, for steel being much harder, and possessed of a much greater tensile strength than puddled iron, it was only reasonable to suppose that the loss of weight from abrasion would be less than that which attends the use of iron.

Notwithstanding the great superiority of steel in reference to the two qualities just named, the experience of the North-Eastern Railway would indicate that the actual wearing away

of the substance of the rail is greater than in the case of iron.

The system known under the name of the North-Eastern Railway consists of 1401 miles of road, exclusive of sidings, of which 954 miles are double and 447 miles are single roads. The rails used are of the double-headed pattern, weighing usually 82 lbs. per yard, set in chairs placed on wooden sleepers. For some time past nothing but steel has been used for renewals, so that, by the end of 1884, 903 miles, chiefly the double way, were of this material, and 498 miles of iron.

The traffic, taking the North-Eastern line as a whole, is probably a fair average representative, in point of extent, of the railways of the United Kingdom; but by far the largest amount is carried on the roads in the county of Durham and in the North and West Ridings of Yorkshire.*

Notwithstanding the short life of some of the iron rails, for the reasons already given, the average duration of the 903 miles of those which have been replaced with steel is 13·4 years, and the average life of those still in use is 12·1 years. From some cause or another, the large increase of traffic being probably the chief one, the inspectors on the line consider ten years as the present life of an iron rail on those parts of the

* The following tables are constructed from the experience of the North-Eastern Railway, the section of the line where the rails were laid being given :—

Section of North-Eastern Main Line.	Opened.	Life of Original Rails. All Iron.			Weight per Yard, Lbs.	Commenced to Relay.	Finished Relaying.
		Max. Yrs.	Min. Yrs.	Average Years.			
York and North Midland .	{1839 / 1846}	15	6	11·06	80	1852	1861
Leeds Northern . .	1848	22	7	15·38	75	1855	1870
York and Darlington .	1843	21	11	16·29	80	1854	1864
Hull and Selby . .	1840	23	13	16·65	65	1853	1863
York and Scarborough .	1845	20	8	17·13	65	1853	1865
Leeds and Selby . .	{1833 / 1847}	22	5	18·40	65	1852	1869
Hull and Scarborough .	1846	28	17	22·99	65	1864	1874

[*Note continued on next page.*

system where the traffic is most severe both in respect to weight and speed. On the other hand, where the traffic is less heavy, even when the speed of the trains is frequently high, as on the York and Scarborough branch, iron rails are now in use which were laid down twenty-two years ago.

The length of time during which steel has been laid down on the North-Eastern system is not sufficiently long to enable its Managers to speak, from actual removals over the whole length, as to its durability. Some, but only an exceedingly small proportion as compared with iron, fail at an early period, not from lamination or crushing, but from fracture. Such as have been removed from this and other causes have averaged ten years of wear.

In the case of rails of malleable iron, renewals are necessary long before their loss of weight from abrasion renders them

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(Continuation of note on previous page.)

The ages of the iron rails in present use on these lines are as follows:—

	Maximum.	Minimum.	Average Years.
York and North Midland . .	15	5	9·52
Leeds Northern	17	7	13·61
York and Darlington . . .	13	5	7·78
Hull and Selby	12	6	9·30
York and Scarborough . . .	21	5	14·25
Leeds and Selby	15	6	11·75
Hull and Scarborough . . .	19	10	12·56

The average annual traffic carried over the under-mentioned railways during the five years ending 1884 was as follows:—

Name of Railway.	Miles Open.	Passengers.	Merchandise.	Minerals.
		Number.	Tons.	Tons.
NORTH-EASTERN . .	1401	32,594,496	8,302,868	29,754,438
London and North-Western .	1862½	52,191,566	8,368,819	26,030,310
Great Western . . .	2236½	47,046,938	5,025,035	17,655,680
Midland	1482	30,290,236	9,732,351	14,417,077
Lancashire and Yorkshire .	485½	39,912,385	4,723,290	9,910,584
Great Northern . . .	679	23,048,123	4,355,588	4,328,628
Great Eastern . . .	973	57,855,369	3,863,809	2,566,307
Caledonian	909	16,696,838	3,068,412	11,487,931
North British . . .	962	17,890,296	3,077,379	9,483,280

unsafe, by reason of their diminished weight and consequent want of the proper strength. This happens, as a rule, when the actual loss from this cause does not exceed 4 or 5 per cent. of the original weight, while in steel rails abrasion proceeds until either the carriage-wheels touch the chairs, or the loss of weight is considered such as to render the rail too light for the work it has to perform. The following are cases of single rails which have been taken up and the loss of weight ascertained:—

TABLE XII.

When Laid.	Steel Rails taken up at:—	Original Weight per Yard.	Years in Use.	Loss of Weight per Yard.	Percentage of Loss on Original Weight.	Analyses.* Per cent.
		Lbs.		Lbs.	Per an'm.	C. Mn. Si. P.
1866	Milford Junction . .	78½	12	8·50	0·90	·27 ·33 ·05 ·06
,,	South end Bramhope Tunnel	80½	12	20.125	2·083	·26 ·26 ·35 ·11
1869	Darlington . . .	82	9	15·250	2·065	·24 ·30 ·05 ·10
1870	Scarborough . . .	82	8	10·50	1·60	·31 ·34 ·19 ·09
1875	Between Croft & Darlington	80	3	1·00	0·42	·42 ·81 ·13 ·07
1876	Darlington . . .	80	2	1·25	0·78	·38 ·67 ·08 ·09
1877	Staddlethorpe . . .	80	1	1·12	1·40	·40 ·72 ·08 ·09

The average percentage of this extraordinary loss of weight is 1·321 per cent. per annum, and if 20 per cent. was considered the extreme at which it would be safe to go, fifteen years would about represent the length of the life of a steel rail.

A piece of road between Gateshead and Pelaw Main Station, 4,554 yards in length, was laid upon the heavy load side with iron rails in April 1859. In May 1869 they were replaced with the same section of rails made of steel, which in their turn had to be removed in June 1879. Practically, therefore, each kind lasted exactly ten years, but in the meantime a marked change had taken place in the traffic. In the year 1868 the Team Valley line was opened, upon which all the London express and some other trains, as well as the through goods trains which formerly went *via* Gateshead and Pelaw

* The substances given in the analyses are carbon, manganese, silicon, and phosphorus.

Main, were despatched. On the other hand, the annual quantity of coal worked from the Northumberland and Durham coalfield averaged 22 million tons for the decade ending 1869, and about 32 millions for that ending in 1879. If this change can be taken as an index of the traffic on the North-Eastern line in general, and on the section in question, the life of the iron rails, estimated by the weight of traffic, would have been worn out in seven years, while those of steel lasted ten years. This more extensive trial would give to the steel rails a life longer by one-half than those of iron. It ought, perhaps, to be mentioned that the stretch of line between Felling and Pelaw Main is in the midst of chemical works, where metal work is speedily corroded, and I am unable to say whether the steel or the iron rails in use suffer most when exposed to such an atmosphere as prevails there.

To get the annual quantity of pig iron required for the renewals, I have calculated that it takes 23½ cwt. of pig to make a ton of steel, and 27½ cwt. a ton of iron, rails; and 21 cwt. to make a ton of chairs.

The following estimates are made on these figures, and on the supposition that an iron rail lasts ten and a steel one fifteen years, and that the loss of weight is 4 per cent and 15 per cent. during the respective periods. The length taken is 100 miles of single way, for which it is assumed 12,000 tons of rails and 7,000 tons of chairs are required.

FOR IRON RAILS—	Tons.
$\frac{1}{10}$th of 12,000 tons	1,200
Waste from abrasion, 4 per cent.	48
Remaining for use in remanufacture	1,152

If we regard these old rails as puddled iron, which they usually take the place of, it may be considered that the 1152 tons will produce 1025, or 175 tons less than the 1200 tons they have to replace.

	Tons of Pig.
Now this loss of weight represents at 27½ cwt. per ton of rails .	240·62
To which add $\frac{1}{20}$th of weight of chairs laid down, viz., 7000, equal to 700, losing 1 cwt. per ton in wear and re-melting . .	35·00
Making together of pig iron per annum	275·62

STEEL RAILS—	Tons.
$\frac{1}{15}$th of 12,000 in use	800
Waste from abrasion taken at 15 per cent. . . .	120
	680
The loss on converting this into rails about . . .	101·28
Giving thus of new rails	578·72

The difference between the last-mentioned number and the quantity it has to replace (800 tons) is 221·28 tons.

	Tons of Pig.
To produce 221·28 tons of rails, 23¾ cwts.	259·99
To which add $\frac{1}{15}$th of 7000 tons of chairs, losing 1 cwt. per ton on 466·66 tons in wear and remelting	23·33
Making together of pig iron per annum	283·32

Thus it appears that although steel rails are made with a smaller consumption of pig iron, and last longer than those of iron, the annual weight of crude metal required for repairs of the permanent way is a trifle larger, on the basis assumed, with the more durable material, owing to the loss while in use.

These calculations as to the loss of weight incurred in the renewals of the permanent way are obviously entirely dependent for accuracy on the actual life of the two kinds of rail. Of iron, experience enables us to speak with certainty; but such is not the case with steel, and should this material be able to resist the wear under the heaviest traffic of the North-Eastern Railway for twenty instead of fifteen years, the loss, as given in pig iron, would be correspondingly affected.

I am disposed, moreover, to think that, unless in very exceptional circumstances, abrasion of steel rails to the extent of 1

per cent. per annum is overstated, because in the case of forty-eight rails recently examined, the yearly loss of weight from this cause averages only ·60 per cent. At the same time, it has to be observed that of these there are six cases (nearly 13 per cent. of the whole) in which the wear exceeded 1 per cent., the particulars of which are given in the footnote,* and in respect to which it is considered that there was nothing, either in the traffic passing over them, or in the quality of the rails, to account for the excessive amount of abrasion.

In twenty years a rail, originally 82 lbs. per yard, would, with an annual loss of ·60 per cent., weigh 72·16 lbs. In testing the iron rails intended to be placed on the North-Eastern line, each specimen selected for trial is placed on supports 3 feet apart, and a weight of 672 lbs. dropped upon it twice from a height of at least 5 feet. The fall is required to be increased to 16 feet before the rails gave way.

For proving the steel rails, which are placed also on supports 3 feet apart, the weight used is one of 1800 lbs., allowed to fall twice from a height of 5 feet, and a third time from a height of 27 feet, which they bear without fracture.

Some very interesting experiments have been tried recently by the inspectors of the permanent way of the North-Eastern Railway on the forty-eight rails just referred to, which confirms the opinion that the continued vibrations of the passing trains

* Particulars of six rails in which the wear exceeded 1 per cent. per annum :—

Annual Abrasion.	Years in Use.	Situation on Main Line.	Contained Per Cent.				
			Carbon.	Silicon.	Sulphur.	Phosphorus.	Manganese.
Per Cent.							
1·01	15	Fence House	·39	·10	·10	·05	·35
1·05	17	Pelaw Main	·28	·02	·07	·09	·23
1·07	9	Sherburn	·45	·07	·12	·05	·67
1·15	12	Leamside	·47	·08	·20	·06	·92
1·29	14	Heaton Station	·41	·06	·13	·09	·45
1·51	10	Pensher	·36	·15	·08	·07	·07

have so altered the molecular structure of the steel as to have greatly impaired the strength of the metal. In the experiments the rails were placed on supports 3 feet apart, and a weight of 1800 lbs. was dropped from different heights, usually commencing with 1 foot, and increasing the fall until fracture took place. The following figures show the particulars of the trials:—

Forty-eight steel rails tried as follows:—

Number of rails tried	6	11	12	2	3	1	1	2	1	2	3	4
Fall in feet at which fracture took place	1	2	3	4	5	6	7	8	9	11	15	15

The last four specimens under the fall of 15 feet did not break.

The average age of the rails when taken out was .	12·04 years
The average loss per annum was	·606 per cent.

The deterioration of strength appeared so serious that two lots of rails, one of iron and one of steel, were submitted to trial under the weight of 672 lbs., of which, when the iron rails were new, two blows of 5 feet and one of 16 feet without fracture were considered satisfactory.

Eighteen iron rails broke as follows:—

Number	8	6	1	2	1
Fall in feet	2	3	4	5	10

Average age, 11·5 years; average total waste, 4·16 per cent. = ·36 % per annum.

Twenty-one steel rails broke:—

Number of rails	3	7	6	2	1	1	1
Fall in feet	3	4	5	7	8	9	17

Average age, 12·66 years; average total waste, 8·42 per cent. = ·66 % per annum.

These two last experiments demonstrate that the iron rails have not lost so much of their original strength as those of steel; but, on the other hand, at the end of the 12·66 years, the steel rails were still abundantly strong for their work. We may infer from these facts that no risk is being encountered from the change which has taken place in the steel rails now in use,

but it is a subject which commends itself to the attention of all railway engineers.

Connected with the expected longer duration of steel rails is the effect it will have on the iron trade of the country, and this, notwithstanding the quantity which has been laid down, has not yet been felt, because steel has merely been employed to take the place of iron rails. The amount of renewals up to this date has therefore been measured not by the life of steel but of iron. Assuming the latter to last 12 and the former 24 years, instead of the railways now in existence in the United Kingdom requiring, as formerly shown, 465,648 tons annually for repairs, 232,824 tons will suffice for the purpose. Although this only involves the saving of a comparatively small weight of pig iron, it means less work for remelting and for our rolling mills say to the extent of 4000 to 5000 tons a week.

I am indebted to my friend, Mr. F. W. Webb, of the London and North-Western Railway, for being reminded that the old rails can be remelted and remanufactured into new rails in a Siemens furnace with a loss of 7½ per cent. If, then, we take the abrasion at ·60 per cent. per annum, and assume the life of a steel rail under heavy traffic to be 24 years, the loss from this cause will be 14·4 per cent., which, added to the waste in re-rolling, will bring up the total loss to 20·8 per cent. on a rail of 82 lbs. We must not, however, lose sight of the fact, that hitherto the Siemens-Martin process has proved a more expensive one than the Bessemer, although personally I think the difference in cost between the two will be reduced.

I will conclude this section of my work by quoting the experience of the North-Eastern Railway Company with the first parcels laid down on their system :—

1862	. .	53 tons	laid down, almost all	replaced in	1873 and 1874
1864	. .	50 „	(German), laid down,	replaced in	1868 to 1873
1865	. .	170 „	laid down	„	1872 and 1873
1866	. .	95 „	(German), laid down	„	1870 to 1876
„	. .	500 „	laid down	„	1874 to 1883
1867	. .	250 „	„	„	1879 to 1882

TABLE XIV.

Year.	Iron.	Steel.	Total Iron and Steel.	Wood.	Grand Total.
1878	517,692	4,470	522,162	52,657	574,819
1879	470,969	16,000	486,969	34,369	521,338
1880	459,994	35,373	495,367	22,297	517,664
1881	696,724	42,407	739,131	18,671	757,802
1882	851,075	125,841	976,916	12,086	989,002
1883	933,774	166,428	1,100,202	16,353	1,116,555
1884	661,201	132,457	793,658	14,050	807,708

The authorities vary in their estimates of the quantity of iron which enters into the construction of the hull of a vessel; most give it at 10 cwts. per gross register ton, and this is the figure I have adopted in my calculation for iron and steel ships alike. From the information received it is computed for every 100 tons of iron in the hull of a steamer there are 23 tons in the machinery and boilers.

Upon these factors the entire consumption of pig iron used in shipbuilding has been estimated:—

TABLE XV.

Year.	Iron and Steel in Hulls of Steamers.	Machinery in Steamers.	Iron and Steel in Hulls of Sailing-Ships.	Total.	Pig Iron at 26 cwts. per ton.
1878	205,333	47,226	55,748	308,307	400,799
1879	225,319	51,823	18,165	295,307	383,899
1880	228,326	52,515	19,357	300,198	390,256
1881	330,840	76,093	38,725	445,658	579,355
1882	427,804	98,395	60,654	586,853	762,909
1883	484,154	111,355	65,946	661,455	859,891
1884	318,774	73,317	78,059	470,150	611,198

We are without much, if indeed we have any, experience sufficient to guide us as yet respecting the weight of iron we may expect from the breaking up of old iron vessels when worn out by use. When that day does arrive it is to be apprehended that the cost of reducing the riveted mass to a state fit for the market will be great. We do, however, know something of

the weight of metal which has disappeared by the loss from shipwreck. Over five of the seven years which have just been examined this has been as follows:—

TABLE XVI.

	Gross Tonnage, 1878.	Gross Tonnage, 1879.	Gross Tonnage, 1880.	Gross Tonnage, 1881.	Gross Tonnage, 1882.
Steam . . .	127,353	115,778	138,370	140,748	193,960
Sailing . . .	92,672	48,695	43,936	46,153	54,261
Pig iron for both (tons)	162,054	124,867	139,188	142,513	190,340

Of the pig iron representing losses at sea no further notice need be taken, because the void created by its disappearance from this cause is included in the new vessels built in each year.

Before proceeding to make a summary of the total weight of iron required by railways and shipbuilding so as to compare the two, an estimate is required for the renewals of the permanent way. Having regard to the weight laid down in the United Kingdom at the end of 1877, and guided by the quantities used by the North-Eastern Company, I have calculated that during the last seven years the loss annually in remanufacturing the rails and chairs taken up in the Kingdom was about 90,000 tons, estimated in pig iron.*

In like manner a provision of iron in the form of pig must be made for the rolling stock, both new and for repairs. As regards the former the estimate is based on one half the weight of iron being consumed for this purpose of that used for laying down the permanent way, including bridges, &c.

The estimated weight of the iron in the entire rolling stock

* In the estimate of the renewal of rails and chairs, the sidings are left out of the calculation, the wear there being very much less than on the main line; besides, the renewals on sidings are generally effected by worn out rails and chairs taken from the main road.

in use on the railways of the United Kingdom at the end of 1877 was considered to be 3,929,296 tons. The average life of the rolling stock when new may be taken at twenty years, but, as a basis of computation, having regard to that which was then running, it has been assumed as being on December 31st, 1877, eleven years. If these factors be admitted, to make good the loss in remanufacturing the worn-out engines and carriages, inclusive of wear and tear, I think that 160,000 tons of pig iron would be annually needed over the seven years to which the comparison applies.

TABLE XVII.

Weight of Pig Iron, including that imported, required for Railways, Shipbuilding, Pipes, and other purposes (1 = 1000).

	1878.	1879.	1880.	1881.	1882.	1883.	1884.
New lines constructed .	154	222	131	84	161	66	149
Renewals of old lines .	90	90	90	90	90	90	90
New rolling stock built .	95	137	81	52	100	40	92
Renewals of old stock * .	160	160	160	160	160	160	160
	499	609	462	386	511	356	491
Shipbuilding . . .	401	384	390	579	763	860	611
Pipe foundries . . .	250	250	250	250	250	250	250
	1,150	1,243	1,102	1,215	1,524	1,466	1,352
Sundry uses . . .	2,207	1,322	2,172	2,213	2,039	2,056	2,011
Total pig iron for home consumption .	3,357	2,565	3,274	3,428	3,563	3,522	3,363

These figures, in Table XVII., representing the quantities of pig iron consumed by railways and shipping, are followed by those for the pipe foundries. I am informed by a manufacturer that the total pig iron consumed for this purpose may be taken at 500,000 tons per annum. Of this one half may be regarded as for home consumption, say 250,000 tons per annum. The last row of figures shows the weight of pig iron formerly ascer-

* The North-Eastern Railway, upon whose experience this estimate is based, includes in its maintenance account a large quantity of iron used in adding to the strength of its rolling stock. This, however, is probably not more than has been done by most other companies.

tained (*vide* Table VII.) as having been consumed for uses in the United Kingdom, and the difference between these and that required for railways, shipbuilding, and pipemaking must be that worked up in those sundry uses, the extent of which it would be difficult and even impossible to ascertain.

It is clear from the statement just given that shipbuilding has latterly presented a much greater outlet for iron than the construction of railways and their renewals have ever afforded or are likely to afford, at all events in this country. Unfortunately the experience of 1884 shows a serious falling off in the demand for naval architecture, and, so far as we can judge, in the absence of the proper returns, 1885 does not promise to be any improvement on its predecessor.

In searching for the cause of the present depreciation of shipping property, and the consequent decrease in the demand for new vessels, we have not far to look. It is, to the extent which the official figures enable us to judge, neither to want of employment nor to foreign competition that the rapid change is to be ascribed. In proof of this I have taken out the figures showing the total tonnage of British and foreign vessels (sailing and steam) which have been entered and cleared at ports in the United Kingdom from and to foreign countries and British possessions, with cargoes only, to which the tonnage of the coastwise trade has been added. To avoid the use of unnecessary figures, alternate years have been taken, from 1870 to 1884, as they are given in the Government Statistical Abstract:—

TABLE XVIII.

	1870.	1872.	1874.	1876.	1878.	1880.	1882.	1884.
British vessels to and from foreign ports	Tonnage. 22,243,039	Tonnage. 25,714,276	Tonnage. 26,761,941	Tonnage. 28,873,724	Tonnage. 30,297,176	Tonnage. 35,885,868	Tonnage. 38,203,006	Tonnage. 40,155,906
Coastwise . .	36,373,424	35,777,049	40,905,637	45,177,233	47,502,961	49,589,336	49,524,140	50,677,585
Foreign vessels to and from foreign ports	9,381,641	11,440,016	12,072,979	13,663,660	12,602,758	13,793,082	14,310,906	13,814,441
Coastwise . .	184,518	244,998	201,807	253,291	195,942	164,137	191,504	208,783

The following are calculations of the tonnage of ballast carried for each 100 tons of cargo during three years :—

TABLE XIX.

Year.	In British Ships.		In Foreign Ships.	
	Entered.	Cleared.	Entered.	Cleared.
1870	20·3	6·3	24·5	22·0
1876	20·5	11·3	16·3	39·2
1884	26·6	9·0	33·3	22·1

Whatever may be said respecting foreign competition in our national trade, it cannot be alleged that vessels navigated under the British flag have not advanced much more rapidly in the carrying of merchandise to and from the United Kingdom, and from one port of the United Kingdom to another, than ships sailing under foreign flags.

The following figures show the extent of the cargo traffic alone in the years 1870 and 1884 :—

TABLE XX.

Year.	Foreign Trade.				Coastwise.			
	British Vessels. Tonnage.		Foreign Vessels. Tonnage.		British Vessels. Tonnage.		Foreign Vessels. Tonnage.	
	Entered.	Cleared.	Entered.	Cleared.	Entered.	Cleared.	Entered.	Cleared.
1884 . .	18,209,236	21,946,670	6,487,449	7,326,992	26,594,874	24,082,711	117,323	91,459
1870 . .	10,308,952	11,934,087	4,601,790	4,779,851	18,210,519	18,162,905	89,756	94,762
Increase .	7,900,284	10,012,583	1,885,659	2,547,141	8,384,355	5,919,806	27,567	...
Decrease .	...	...	...	...	...	...	...	3303
Increase °/₀	76·6	83·9	41·0	53·	46·0	32·6	30·7	...
Decrease °/₀	..	...	...	...	...	...	...	3·15

This superior advance of English shipping, in comparison with that of foreign nations engaged in trade connected with the United Kingdom, may possibly be due to some extent to the foreign shipowners preferring employment at home. It has, however, to be remarked, that in no kind of work ought the foreigner to be better able to compete with ourselves than in the carrying trade. Unlike a manufactory which, being located abroad, has to send its produce to our shores, a foreign ship being in a British port is, or ought to be, as well able to carry cheaply as one sailing under our own flag. The foreign shipowners, indeed, enjoy an advantage over those of our own countrymen in the shipping laws recently enacted. Whatever may be the urgency of the conditions these laws impose, there is no doubt that their observance implies a money loss upon the British shipowner from which the foreigner is exempt.

If, then, the tonnage employed has not fallen off, the only way to account for the present greatly depressed state of this interest is by the undue increase of our mercantile shipping. By referring to the figures just set forth, the work performed by the vessels of the United Kingdom in 1870 and 1884 has been as follows:—

TABLE XXI.

	Foreign Trade.	Coastwise.	Total.
1870.			
Entered . .	10,308,952	18,210,519	28,519,471
Cleared . .	11,934,087	18,162,905	30,096,992
	22,243,039	36,373,424	58,616,463
1884.			
Entered . .	18,209,236	26,594,874	44,804,110
Cleared . .	21,946,670	24,082,711	46,029,381
	40,155,906	50,677,585	90,833,491
Increase . .	17,912,867	14,304,161	32,217,028
Increase per cent.	80·5	39·3	54·9

Not only has the tonnage greatly increased in 1884 over

that of 1870, but the character of the ships has been changed. In 1870 only 18·6 per cent. consisted of steamers, whereas in 1884, 53·2 per cent. of the merchant navy was propelled by steam. Owing to the space occupied by machinery, the carrying-power, including fuel for engines, of a steamer is about 16 per cent. less than that of a sailing-vessel of similar dimensions. On the other hand, the steamships probably make 3½ times as many voyages as those which are dependent on the wind. The net result is, that although the increase in the tonnage of 1884 is only about 27 per cent. above that of 1870, the carrying-power from the causes assigned, is between 80 and 90 per cent. in excess of this latter year. But the increase in the weight to be carried between the two years has, as has been shown, only risen about 53 per cent., so that the difference between these two sets of figures would represent, were there no other disturbing influence at work, the excess of shipping accommodation.

The fact that vessels sailing under the British flag are and have been largely employed in trading between one foreign port and another, prevents any accurate comparison being made of the actual amount of work performed by the mercantile fleet of the United Kingdom. The present low rates of freight have driven the British shipowners to seek employment in this direction. As an example a steamer carrying 2000 tons will take, say coals, to the Mediterranean, and owing to the low rates of freight—8s. 6d. per ton—500 tons will be reserved for ship's use instead of purchasing dear coal at Malta or elsewhere. The vessel will then load 1700 tons of iron ore for the United States, which is now done at 9s. 6d. per ton. This is a rate the American ironmasters can afford to pay, but might prefer native ore to paying 12s. or 13s. carriage on foreign ore. By this time the 500 tons of bunker coal are exhausted, and the captain has to replenish his stock, perhaps at New York or Philadelphia, at a cost of 13s. to 14s. per ton instead of 8s. to 10s., which is the price in the United

Kingdom. He may then sail for a home port, or as is just as likely, he may load for a port on the continent of Europe. Thus only one of his voyages out of three will appear in the trading statistics of the United Kingdom.

According to the information I have received from a very well informed source, the actual amount of unemployed tonnage is not a very large one. Small, however, as this may be, its depressing effect on the freight market, in some cases 25 per cent., is most disastrous, and has caused a depreciation of something like 33 per cent. on the value of shipping property.

It may seem surprising that builders and investors should not have ceased to launch and to put more capital into shipping before the excess of accommodation over employment had reached the point just mentioned, for that there were more vessels than were required was and is proved by those which are now, and have been for some time, lying unemployed in our harbours.

To some extent this is to be accounted for by the nature of the trade. Down to the years 1882 or 1883 there must have been an actual scarcity of ships, as was evidenced by the high rates of freight and consequent great profits to the shipowner. In the meantime, persons often of very small means, all over the country, were induced by ship managers to put their money into new vessels. Orders were given, and these had to be executed long after it was apparent that the market was overstocked. In connection with raising money under a system of limited liability the question suggests itself whether its advantages are not frequently accompanied by a want of due inquiry and thought on the part of those who intrust their money to the keeping and management of interested parties.

The superior strength of steel over iron has a peculiar advantage when used in shipbuilding. According to tests made by Mr. Kirkaldy the breaking strain of best steel boiler-plates is about 84,000 lbs. to the square inch against something under 50,000 for iron, the strain in each case being applied lengthways.

Steel possesses the further recommendation of being equally strong whether the strain is applied lengthways or crossways in the plate, whereas iron is nearly 10 per cent. weaker in the latter than in the former case. These figures bring out an apparent superiority in resisting fracture of above 70 per cent. in favour of steel; but other returns received show a difference of only 45 per cent. between ship plates of the two kinds of material.

Neither of these numbers, however, expresses the reduction of weight when using steel as compared with iron in the construction of a ship, because, owing to the constant change in the direction of the strain at sea, the metal is at one time under tension, and at another under compression, and in the latter case thickness is of more importance than mere tensile strength. Mr. B. Martell, chief surveyor at Lloyd's, estimated in 1878 that a sailing-vessel of 1700 gross register tons to class 100A would require in its construction 840 tons of iron against 680 if of steel, or a reduction in weight of about 19 per cent. This means that a steel vessel of the dimensions just named would be able to carry 160 tons more cargo than one of iron.

With these facts before us it may be asked what has retarded the use of steel for shipbuilding, for in the year 1880 only about 10 per cent. of the vessels built were of this material against 90 of iron, and in no one year up to the end of 1884 has above 83,200 tons of steel been employed. This was in the year 1883, when the weight of iron and steel used in our shipyards was above 661,455 tons. The delay must be ascribed to the difference in price, for in the year 1880, when iron plates averaged £6. 5s. 0d. per ton, steel was charged £11. 14s. 6d. This great difference was partly due to an excessive demand for hæmatite iron in that year, which caused it to rise in value until it was 42s. above that of Cleveland iron, the difference now (1885) being about 10s. It has also to be observed that the steel-makers, owing to the want of any great demand, had not applied themselves seriously to the

manufacture of plates, in the same way that they had done with regard to rails. Since then a great deal has been accomplished in this direction, and now, instead of such a difference of price as that which obtained in 1880—£6. 9s. 6d. per ton—steel plates are now selling at £6. 2s. 6d. against £4. 12s. 6d. for iron. The present difference in weight between using iron and steel in a vessel amounts to about 14 per cent., a difference of 5 per cent. from Mr. Martell's estimate. This would make it appear that steel is, at the prices quoted, dearer than iron for a ship of *similar dimensions*. As a fact, however, I know of an instance where a vessel, having to carry a given weight of cargo, is, partly from the reduced weight of material, and partly from a reduction in the dimensions of the ship, owing to its greater carrying capacity, being built of steel, the purchaser having had the choice, for the same price, of taking iron or steel.

In order to form an idea of the proportion of the quantity of finished iron now being made which, from superiority of strength, would probably be better of steel, I have taken out the different kinds of malleable iron manufactured in 1884, as they are set forth in Mr. Jeans' Report to the British Iron Trade Association. They are as follows:—

TABLE XXII.

	Bars.	Strips.	Hoops.	Plates and Sheets.	Angles and Tees.	Wire Rods.	Rails.	Fish Plates.	Nail Rods.	Totals.
North-East of England	81,576	...	...	270,906	72,278	...	3,515	...	...	428,275
SouthStaffordshire	132,747	61,603	31,500	89,858	...	...	...	...	5,736	321,444
Lancashire	67,109	326	43,595	41,583	2,145	42,852	1,500	...	...	199,110
South Wales	85,507	...	...	9,057	860	...	10,542	1,622	981	108,569
Scotland	43,240	598	8,491	12,359	7,436	1,141	86	...	5,741	79,092
Totals	410,179	62,527	83,586	423,763	82,719	43,993	15,643	1,622	12,458	1,136,490

These figures do not correspond with the full quantity of finished malleable iron which ought to have been produced from the puddled iron given in Mr. Jeans' Report (2,237,535 tons), and which ought to have afforded 1,950,000 tons. There

are, however, certain districts from which Mr. Jeans has no returns; besides which, some puddled iron may have been exported, but being classed in the "exports" with pig iron, the quantity cannot be ascertained. Assuming, however, 1,950,000 tons of finished iron as the quantity, and that the weight from unspecified localities corresponds in description with those given above, something like 1,170,000 tons of this would probably be better of steel than of iron. This leaves out the "bars" entirely, part of which might also be usefully superseded by steel. The circumstance which will probably determine the preference between the two will be that of price.

Leaving speculation as to the future of the steel and malleable iron trades, I annex the quantities of ingots and puddled iron produced in the last four years as they appear in Mr. Jeans' Report:—

TABLE XXIII.

	1881.	1882.	1883.	1884.
Puddled iron . . .	2,681,150	2,841,534	2,730,504	2,237,535
Steel ingots . . .	1,779,719	2,109,649	2,008,880	1,761,641
	4,460,869	4,951,183	4,739,384	3,999,176
Percentage consisting of steel	40·1	42·6	42·4	44·1

These numbers do not indicate that steel has really greatly displaced ordinary malleable iron in the ironworks of the United Kingdom since 1881. If the metal in the form of steel is really stronger than puddled iron, and if when, in the form of mild steel, as it is termed, *i.e.*, when the carbon is lower in amount than in hard steel, it is capable of being welded as easily as ordinary malleable iron, one may wonder how the latter has maintained its ground as well as it has done down to the present day. It must, however, be remembered

that the manipulation of steel in the smith's fire is somewhat different from that of puddled iron, and that a considerable quantity of the latter metal passes in very small lots for general purposes through the hands of persons who, finding some difficulty in working steel, keep to the article they have been accustomed to use.

Possibly also another objection raised against steel has operated against its more general adoption, viz., its alleged greater liability to a molecular change of structure from vibration when in use. Cases have been quoted of the steel shafts of screw-steamers having given way, and these failures have been set down to the material itself. The same fate has attended the use of malleable iron, but it is only natural that with a new substance, greater apprehension should exist than with an old one. Time alone can settle a question which is essentially one of experience. In the meantime, after a most careful consideration and ample investigation of the properties of steel, the engineers of the Forth Bridge decided not only that it was well suited to stand the vibration of heavy trains passing along spans of unexampled length (1730 feet), but I believe that it was the only material deemed by them fit for the construction of this gigantic undertaking. On the other hand, we cannot afford to disregard the lesson taught us by the effect on rails of passing trains, as explained in speaking of the durability of steel when used for this purpose.

It requires no argument to prove that the world has been a great gainer by the substitution of steel for iron, but this advantage has not been obtained without some one having been inconvenienced by the change, and this will be continued in a greater or less degree, by every additional quantity of puddled iron which is displaced by the stronger and better material.

It may be interesting to consider, very shortly, the effect on existing interests involved in producing 1¼ million tons of rails—the annual make of Great Britain—of steel instead of iron, for

which, it will be assumed for the present purpose, that foreign ore has been used.

Having regard to the reduced quantity of coal required to manufacture steel rails as compared with iron; to the labour necessary for working the English ironstone which we possess in such abundance; and to the smaller amount of wages paid for steel, I estimate that on the 1¼ million tons the alteration is equivalent to the withdrawal of 2 to 2½ million sterling a year from those who would have found employment in manufacturing iron rails beyond the number engaged in making them of steel. In addition to this we have puddling forges, rolling mills, with all the requisite plant for turning out this amount of work in iron laid aside, and representing a capital of about 2½ million pounds. To some extent the iron rail mills would have been able to roll steel instead of iron, but, with the recent improvements in the new mills, this would have been under such disadvantage that ultimately the old establishments would have been abandoned, as indeed in many cases they actually now are.

I have so far endeavoured to explain—1st, the growth of the British iron trade; 2nd, upon what sources of supply of ore this growth has been dependent; and 3rd, to what extent the pig iron produced in Great Britain has been either exported as such or sent abroad in the form of machinery, rails, pipes, &c. &c. I will now proceed to show at what rate, concurrently with our own, foreign nations have advanced in this branch of metallurgical industry.

As nearly as I can estimate from the different authorities, the subjoined list contains, but only approximately, the make of pig iron of the eight nations named below for the years 1800 and 1830:—

TABLE XXIV.

	1800.	1830.
United Kingdom . . .	200,000	678,000
Germany	200,000	300,000
France	140,000	223,000
Russia	90,000	161,000
Sweden	60,000	90,000
Austria	50,000	79,000
United States . . .	45,000	191,500
Belgium	...	85,000
Total	785,000	1,807,500
Great Britain . . .	24·2	37·5
Other countries . . .	75·8	62·5
	100·	100·

In the year 1850 there was produced in the United Kingdom about 2½ million tons; in the United States, 564,000 tons; France, 415,000 tons; Germany, 250,000 tons; Russia, 227,000 tons; Austro-Hungary, 220,000 tons; Sweden, 151,000 tons; Belgium, 150,000 tons; in all, 4,627,000 tons; so that perhaps the make of pig iron in the whole world would not greatly, in that year, exceed 4¾ million tons.

In dealing with the progress of iron-making in the United Kingdom, I have confined myself, when entering into details, to a period of years commencing at 1870. I propose doing the same in speaking of the rest of the world, and I commence this portion of my work by showing the advance made by what practically includes all the iron-making nations. The table which follows shows, in quantities of a thousand tons, the make of pig iron in Great Britain and in foreign nations:—

TABLE XXV. (1 = 1000).

	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.
Great Britain . .	5,963	6,627	6,741	6,566	5,991	6,365	6,555	6,608	6,381	5,995	7,749	8,144	8,586	8,529	7,812
Six next largest iron-producing nations*	5,242	5,457	7,204	7,703	7,090	6,808	6,404	6,737	7,190	7,513	9,768	10,563	11,560	11,934	11,819
Other nations† .	360	380	400	420	440	460	480	500	520	540	560	570	580	600	650
Total . . .	11,565	12,464	14,345	14,689	13,521	13,633	13,439	13,845	14,091	14,048	18,077	19,277	20,726	21,063	20,281‡
Per Cent. of Total Make:—															
By Great Britain .	51·6	53·2	47·0	44·7	44·3	46·7	48·9	47·7	45·2	42·7	42·9	42·3	41·5	40·5	38·5
By all other countries	48·4	46·8	53·0	45·3	55·7	53·3	51·1	52·3	54·8	57·3	57·1	57·7	58·5	59·5	61·5
	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100 0	100·0	100·0	100·0
The increase on 1870 appears to have been at the following rate:—															
Great Britain .	100·0	111·1	113·0	110·1	100·5	106·7	109·9	110·8	107·1	100·5	129·9	136·5	143·9	143·0	131·0
All other countries	100·0	111·3	145·0	154·9	143·6	138·6	131·3	138·0	147·1	153·6	197·0	212·4	231·9	239·1	237·9
Average of both .	100·0	107·8	124·0	127·0	116·9	117·9	115·3	119·7	121·8	121·4	156·3	175·3	179·2	182·2	175·4

* In this line are included the United States, Germany, France, Belgium, Sweden, and Austro-Hungary.
† Russia, Spain, and Italy are here estimated from certain records which I have consulted.
‡ In the "Statistics of the American and Foreign Iron Trade for 1883" the following is given as the make of the world:—

Great Britain	1883	8,490,224
United States	,,	4,595,510
Germany and Luxemburg . . .	,,	3,397,588
France	,,	2,067,387
Belgium	,,	770,659
Austro-Hungary	,,	655,221
Russia	1881	462,042
Sweden	1882	399,001
Spain	1880	85,939
Italy	1883	53,000
Other Countries	1882	100,000
		21,076,571

It will be found that the growth of the total manufacture of pig iron in the world in 1870 was a mere trifle above 2¼ per cent. per annum up to the end of 1879. At the same time it has to be observed, that the increase is chiefly due to the action of foreign nations and not to ourselves. A great bound took place in 1880, when our own production rose 30 per cent. on the make of 1879, a year, however, of great depression, and the other iron-producing countries show an even slightly greater increase. The production went on in growth, until in 1883 the advance among all nations reached 182·2 per cent. on the make of 1870; that of the United Kingdom being 143·0, and of other countries 239·1 per cent.

The enormous increase, however, has taken place since 1879, the magnitude of which will be best seen by consulting the few lines of figures inserted below:—

TABLE XXVI. (1 = 1000).

	1880.	1881.	1882.	1883.	1884.
Make . . .	18,077	19,277	20,726	21,063	20,281
Make of 1879 . .	14,048	14,048	14,048	14,048	14,048
Increase . .	4,029	5,229	6,678	7,015	6,233
Percentage increase on 1879 . .	28·7	37·9	47·5	49·9	44·3

In order to ascertain to what cause these enormous, and, as it will appear, general increases in the make of pig iron have been due, I have taken out the quantities of certain sources of consumption as they are found specified in the statistical works of the different countries.

The following table of figures compares the consumption in the United States with that of the United Kingdom:—

TABLE XXVII.

United States.	1878.	1879.	1880.	1881.	1882.	1883.
Imported:—						
Castings . . .	69	61	114	632	2,079	...
Bar iron . . .	33,346	48,840	126,987	47,820	79,220	47,409
Band, hoop, and scroll iron . .	7	1031	25,322	827	6,021	1,003
Rails, iron . .	...	19,090	132,459	137,013	41,992	757
Do., steel . .	10	25,057	158,230	249,308	182,135	38,220
Plates and sheets .	839	5,550	11,580	8,411	13,160	9,114
Anchors . . .	646	892	1,393	1,520	1,530	...
Tin plates . .	120,808	172,760	177,015	204,966	239,665	247,781
Net tons of 2000 lbs.	155,725	273,281	633,100	650,497	565,802	344,284
Equal to tons of 2240 lbs.	139,036	244,894	565,268	580,800	505,180	307,397
Equivalent in pig iron at 25½ cwts per ton	188,270	312,239	720,716	740,520	644,104	391,931
Pig and scrap imported . .	72,061	525,982	1,320,753	599,948	687,108	386,934
Pig iron made in the United States	2,301,215	2,741,852	3,835,190	4,144,353	4,623,322	4,595,510
	2,561,546	3,580,073	5,876,659	5,484,821	5,954,534	5,374,375
Less exported as machinery, &c.* .	193,606	173,461	179,398	213,182	265,647	271,896
Net consumption in United States .	2,376,940	3,406,612	5,697,261	5,271,639	5,688,887	5,102,479
Weight consumed in Great Britain as per page 46 . .	3,357,000	2,565,000	3,274,000	3,428,000	3,563,000	3,522,000

* As in the case of the United Kingdom, it is impossible to estimate the weight of iron in the machinery and other objects exported, owing to the value only being given. I have, however, adopted the same plan as that pursued when dealing with Great Britain, by assuming that each £30 represents one ton.

Exports from United States.	1878.	1879.	1880.	1881.	1882.	1883.
Malleable iron and steel . .	15,295	7,665	5,196	5,455	8,188	9,031
Do. reduced to pig iron, at 25½ cwt. per ton .	19,501	9,773	6,625	6,955	10,440	11,514
Pig iron . . .	2,934	1,145	1,871	6,158	6,245	4,221
Machinery as below	171,171	162,543	170,902	200,069	248,962	256,161
Total . .	193,606	173,461	179,398	213,182	265,647	271,896
			MACHINERY.			
	£	£	£	£	£	£
Value . . .	3,434,348	3,250,855	3,418,044	4,001,385	4,977,241	5,123,241
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
Weight . . .	114,478	108,362	113,935	133,379	165,908	170,774
Weight reduced to pig iron, at 30 cwt. per ton .	171,171	162,543	170,902	200,069	248,962	256,161

In order to ascertain the progress and the character of the movement in the iron trade of the world, I have selected for example the chief iron manufacturing countries. A period of ten years has been selected, beginning at 1874 and ending at 1883; the make of pig iron has been given in each case, and in the second and third columns the quantities of iron exported and imported by each nation (1=1000 tons):—

TABLE XXVIII.

	Produced.			Exported.			Imported.		
	Pig.	Mal. Iron.	Steel.	Pig.	Mal. Iron.	Steel.	Pig.	Mal. Iron.	Steel.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
UNITED KINGDOM—									
1874 . .	5991	1797	630	1688*	819		...	125	
1883 . .	8529	2730	2008	1661	2382		...	316	
UNITED STATES—								338	
1874 . .	2401	1512	209	...			92		
1883 . .	4595	2096	1553	271			504	289	112
GERMANY—									
1874 . .	1906	1207	354	207	84	8	531	8	5
1883 . .	3380	1449	1060	258	853	32	274	53	...
FRANCE—									
1874 . .	1423	862	217	51	...	...	122	56	5
1883 . .	2069	1000	460	...	44	...	310	11	...
BELGIUM—									
1874 . .	532	510	36	16	227	5	158	20	10
1883 . .	783	487	179	12	382	90	172	37	5

At the present day public attention is frequently directed by the newspaper press and otherwise, to the importations of iron in various forms, received by this country chiefly from Germany and Belgium.

Of late years this has gone on increasing until it has reached what may be regarded as something above 300,000 tons, say equivalent to 400,000 tons of pig iron or about 5 per cent. of our own make. In 1873 it was only about 125,000 tons, equal to say 155,000 tons of pig iron.

* Scrap iron for remanufacture is included in the pig iron exported from the United Kingdom.

The United Kingdom, on the other hand, has not been idle in the matter of exports, for of pig and different kinds of iron and steel we sent out in 1874 about 2½ million tons, or including machinery probably close on 3½ million tons. This was increased in 1883 to about 4 million tons of different varieties of iron, which with machinery was probably not far short of 4½ million tons. In pig iron, we may take it at nearly 3½ million tons in the former and 5¼ million tons in the latter years, or an increase of about 50 per cent.

Exclusive of machinery, the exports of iron and steel to Germany and Belgium (which countries by certain parties are regarded almost in the light of offenders) have been in the following years the quantities shown in Table XXIX. To these has been added Holland, because the greater part of its imports are merely *in transitu* to Germany or Belgium.

TABLE XXIX.

Exports from United Kingdom	1878.	1880.	1883.
To Germany	299,091	277,273	378,561
„ Holland	268,020	215,575	270,776
„ Belgium	99,406	127,859	105,604
	666,517	620,707	754,941

Connected with the subject of exports from this country, I would here remark that a considerable number of iron vessels is built in Great Britain for foreign account. These, therefore, should be included in our exports. From the manner in which the shipping accounts are kept, I am uncertain as to what extent these are included in the figures already given in reference to that interest. The following figures show the *net tonnage* built for foreign account in recent years:—

1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.
51,507	17,655	17,269	42,474	49,156	69,055	107,694	115,776	123,640

In order to avoid the effect of the great competition which has arisen among the steel rail-manufacturing powers of Great Britain, Germany, and Belgium, the ironmasters of these three countries have agreed to divide the orders in a certain fashion. The result has been that in 1884 and in ten months of 1885, 246,370 tons fell to the share of Germany and Belgium.

In discussing the relative position of this country with foreign nations, possibly from an imperfect knowledge of the facts, comparisons have occasionally been drawn in a way which assigns to our own manufacturers a rank inferior to their neighbours in point of skill, both scientific and practical.

The importation of rolled girders has had so often to stand sponsor to this opinion, that I have taken some pains to ascertain the facts of the case.

There is no doubt that until very recently, whenever an order for this kind of iron was in the market, the English makers were undersold by their continental neighbours. This gave rise to the belief that Middlesbrough pig iron could be conveyed to Belgium or Germany, there converted into girders, and returned to this country, on terms which our dearer labour and supposed inferior skill could not compete with.

The proper explanation is, that iron of the description in question was so largely introduced into architectural work by foreign engineers and architects, that very good mills were erected for its manufacture, at which it paid the foreign makers to keep large stocks of girders of different dimensions on hand. This enabled the manufacturer, without having to change the rolls, to execute individual orders of inconsiderable magnitude at a very short notice.

Ultimately the demand in this country became sufficient to keep girder-mills at constant work, and we have now examples of this kind of machinery quite equal to anything I have seen abroad. One of the last erected, viz., that of Dorman, Long & Co. of Middlesbrough, I have been permitted to examine, and

by the favour of this firm I have been placed in a position to compare their costs, and consequently their skill, with that of foreign manufacturers, by aid of actual figures handed to me by both. These I am not at liberty to make public, but it may interest the Commissioners to know that there is a substantial superiority in favour of the Middlesbrough mill on the score of economical production.

I have not given many figures to show the comparative position of the different countries in connection with their export and import trades, but perhaps what has been mentioned will suffice. The chief increase is exhibited by the German Empire, in reference to which a little will be said hereafter.

It may be convenient at present to observe that there is no nation which, from the irregularity in its requirements, followed by an irregularity in its imports, has affected the iron trade of the world more than the United States. This may be seen by figures, in Table XXX., which are taken from the reports of the British Iron Trade Association, which do not, I think, include machinery:—

TABLE XXX.

Showing Imports of Iron and Steel into the following Countries from the United Kingdom (1 = 1000):—

	1878.	1879.	1880.	1881.	1882.	1883.
United States . .	159	721	1370	1175	1212	707
Germany . . .	299	269	277	306	362	378
Holland . . .	268	248	215	251	338	271
Belgium . . .	99	91	128	91	100	105
France	114	103	119	183	214	202
Russia	190	232	236	192	167	157

Having now dealt with the production of iron in certain countries, and to some extent with the mode of its disposal, it is now intended to consider the natural facilities possessed by some of them in an iron-making point of view.

COAL.—The resources of different nations in respect to coal may in some degree be judged by the extent of the output. For this purpose the following figures, in millions of tons, have been selected:—

TABLE XXXI.

Year.	United Kingdom.	United States.	Germany.	France.	Belgium.	Russia.	Austria.
1870 . .	109	35½	26¼	13¼	13½	⅜	4¼
1875 . .	131¾	46½	37¼	16⅜	15	1⅜	5
1880 . .	146¾	70	46¾	19¼	16¾	3	6½
1883 . .	163¾	96	55	21½	18	3½	6½

Of all European countries, so far as our present knowledge permits us to form an opinion, the United Kingdom, having regard to its area, is one of the most highly favoured, not only in point of extent of her coalfields, but also in point of quality of their produce. On the whole, the British coal is freer from ash than most others, and in certain districts, Durham County being a good example, the blast-furnace coke it yields is of excellent quality. It must not, however, be overlooked that the output of the Durham coalfield is so large—the average being above 29 million tons for the last three years—that before long it will be unequal to maintaining the present demand made upon it. It may be assumed that of this quantity from 10 to 11 million tons are required for the iron and steel works alone.

It has been estimated that the united area of the known coal-

fields in Great Britain is something over 8000 square miles. Great as our wealth is in respect to fossil coal, we occupy but an insignificant position when compared with the United States, the extent of coal there already known being probably nearly double the entire surface of the United Kingdom. Every known variety of coal is to be had in this new country in unparalleled abundance, the bituminous variety producing good coke and excellent gas, and the anthracite, being so rich in fixed carbon, may be regarded as a natural coke. Besides fuel in the solid form, enormous quantities of petroleum are obtained from the so-called oil-wells, and recently immense, and so far apparently inexhaustible subterranean magazines of gas have been struck which furnish, through miles of pipes laid for the purpose, the means of raising steam and heating iron in the mills and forges of Pittsburg, &c.

There is, however, something beyond the quantity and quality of the coal possessed by a nation which is of paramount importance, viz., the facility with which the produce of the mines can be raised to the surface.

A convenient mode of estimating the character of the beds of coal of a country, is by ascertaining the weight raised per individual engaged in its extraction.

Mr. Meade, Assistant-Keeper of Mining Records, in his excellent work on the coal and iron industries of the kingdom, states that now careful estimates are made by H.M. Inspectors of Mines of the numbers of men engaged under and above ground, together with the quantity of coal raised. From these data he estimates the coal raised per individual engaged to be as follows in the whole country :—

	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.
Tons . .	250	235	245	266	278	279	280	303

According to certain returns, it was made to appear that the amount of work performed per individual at the coal-mines was formerly, in all probability, in excess of the truth, owing to all the hands employed not being included in the accounts.

Thus, in 1870, the output for Northumberland, Durham, and Cumberland was stated to have been 390 tons, which fell in the year 1872 to 360 tons, and in 1873 to 296 tons. Both the last two were years of high prices, but that for 1873 is most likely nearest the truth, because, under the Act of 1872, official returns of all persons employed are required to be made. There is no doubt, however, of the fact, that in the years of high prices, when the wages were largely increased, the men did much less work, for since then coal has fallen greatly in value, and the output per individual has greatly risen.* The following figures give the work done in the three counties referred to from 1873 to 1880:—

	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.
Tons . .	296	308	316	319	318	325	321	368

According to the Report of the British Iron Trade Association in 1881, the average quantity raised per individual working in the three chief iron-producing countries on the continent of Europe was as follows:—

	Germany.	France.	Belgium.
1881 . . .	261	186	165
1882 . . .	266	190	169
1883 . . .	269	...	173
Average . .	265·3	188	169

The reluctance in years of high prices to keep to the standard of the work of times of low prices, noticeable in British collieries, does not appear to obtain favour with foreign miners. I have taken out the figures showing the weight of coal raised in Northumberland and Durham, and compared it with France and Belgium during four years, from which it will be seen that while the pits of these two countries increased their output,

* It ought, however, to be observed that a very large number of fresh mining operations were in progress about the year 1873, in which many workmen would be engaged, although not directly occupied in mining coal; the effect of this, regardless of workmen's irregularities, would be to reduce the comparative quantity won per man employed in and *about* the mines: in the more recent years—as, for instance, in 1880—a much greater proportion of the workmen has, undoubtedly, been employed directly in the operation of coal-getting.

more particularly in 1873, those in the two English counties fell off:—

TABLE XXXII.

	Northumberland and Durham.	France.	Belgium.
1872—year of rising prices . .	30,395,000	15,802,514	15,658,948
1873—year of highest prices .	29,640,000	17,485,786	15,778,401
1874—year of high prices . .	30,543,800	16,949,032	14,669,629
1875—year of prices declining .	32,097,323	17,164,704	15,011,331

I am not aware whether any such account is kept of the coal worked in the United States; as far, however, as Europe is concerned the miners of Great Britain win 24 per cent. more coal than those of Germany, 75 per cent. more than of France, and 95 per cent. more than the miners of Belgium, although the British miners work shorter hours than is done on the Continent. This difference is in a great part due to the less favourable natural conditions of the seams of coal abroad than with ourselves.

As a fuel for smelting iron, fossil coal has its value dependent on the fixed carbon it contains. This confers great advantage on anthracite, which sometimes consists of as much as 92 per cent. of carbon in this form against about 70 per cent. in the bituminous coal of the county of Durham. The latter being totally unsuitable for iron smelting in its raw state, requires to be coked, a process which is attended with some loss of calorific power, and the waste of certain valuable products resulting from the distillation of the coal. By a French invention these, consisting of tar and ammonia, are now being collected at two or three collieries in Durham. Certain varieties of bituminous coal can also be used in the blast furnace, and in certain places in Scotland where raw coal is so employed, ammonia and tar are now being collected. This condensation of so useful a substance to agriculture as ammonia, is a subject of national

interest, because since the introduction of this system of condensation sulphate of ammonia has fallen in price from about £20. to £11. per ton.

I do not propose to make any attempt in this place to trace any difference in the duty performed by the coal of the different nations in iron smelting. The condition of the ores used is such as would render the inquiry a work of great labour, and it would after all not be necessary to account for a very large amount of relative inferiority.

Although the rateable increase in the output of France and Belgium between 1870 and 1883 is considerable, the actual amount is not a large one, it being only 8½ million tons in the former, and 4½ million tons in the latter; whereas, practically there exists no limit, for a long time, to the additional supply the United Kingdom, the United States and Germany could produce. France is a large importer of coal—about 10 million tons per annum—equal to about one-half of her own output. Belgium, on the other hand, exports about 4½ million tons of coal, and nearly one million tons of coke, almost the whole of which latter is received by France.

In the year 1878 the selling price of coal in Westphalia was given me as being 5s. 2½d. to 5s. 3d. at the pit, and in 1882 it was selling at 5s. 2d. to 5s. 5d. In Belgium, where the cost of extraction is much higher than at the Rhenish collieries, the price varied in 1878 from 7s. 1½d. to 10s. 3½d. per ton, which also resembled the market value of coal in many parts of France. Westphalia may therefore be regarded as being as favourably circumstanced as the county of Durham, whereas Belgium and France pay from 2s. to 5s. per ton more for their coal.

Dear as labour is in the United States, the coking coal of the Connellsville district, near Pittsburg, is so cheaply worked that coke has been sold at the ovens at 3s. 8d. per ton or less, or about half the lowest price of Durham coke. Anthracite coal, on the other hand, often commanded a very much higher price for blast

furnaces, but this was partly owing to a combination among the coalowners and railways to keep up prices. This subject, however, and other matters connected with the cost of coal in the manufacture of iron in the United States, will receive further attention at a later period.

ORE.—As to the materials used in the production of pig iron, it is, on account of the cost of transport, important that the smelting works should, other things being equal, be placed near the iron mines. One ton of pig requires for its manufacture 23 to 25 cwts. of coke, whereas of the ore 40 to 60 cwts. are needed, according to its richness. Of limestone there is so small a weight used that its geographical position rarely, if ever, determines the location of the blast furnace. Besides the simple consideration of seeking to convey the smaller weights over the longer, and the greater weights over the shorter distances, there are other objects to be kept in view, such as the position of the markets, &c. Having regard to all the circumstances, and looking at the question in its entirety, Great Britain stands, on the whole, unequalled. The ores are rarely very distant from the coal, and generally both have limestone in their close vicinity. In addition to this juxtaposition of the minerals, the works are most frequently placed at no great distance from a navigable river or from the sea-coast. This combination of circumstances places a country smelting its own as well as imported ore on a very favourable footing. Hence Great Britain, with an extent of fields of ironstone which leaves nothing to be desired, when her own mines of hematite proved unequal to meet her requirements, was able, at a small cost for transport, to bring large quantities of this mineral from Spain and elsewhere. The extent to which the British ironmasters availed themselves of this privilege will appear in Table XXXIII., which contains the average of three years of home-worked and imported ore taken from the statistical returns for five countries—from which that exported has been deducted (1 = 1000):—

TABLE XXXIII.*

	United Kingdom.	Germany.	United States.	France.	Belgium.
Ore raised, average of three years ending 1882. .	17,868	7691	7015	3250	216
Ore imported. . . .	2,789	669	621	1356	1612
	20,657	8360	7636	4606	1828
Ore exported. . . .	61	1442	nil	120	367
Leaving for home consumption	20,596	6918	7636	4486	1461
Pig iron produced, average of the three years . .	8,149	2947	4201	1964	783
Tons of ore required per ton of pig iron . . .	2·52	2·35	1·82	2·28	1·86

We do not possess in this country any general statistical account of the number of men engaged in mining iron ore or of the work they perform.

Such information as I have been able to collect on the subject has been taken from Mr. Meade's book, already referred to:—

TABLE XXXIV.

Ore Worked.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.
COUNTY OF DURHAM — Spathose and Hematite— Tons per man per annum .	178	207	202	140	229	166	116	232
CLEVELAND IN YORKSHIRE—Clay Ironstone from Middle Lias— Tons per man per annum .	581	551	623	667	735	784	695	808
CUMBERLAND—Red Hematite— Tons per man per annum .	206	227	205	215	232	221	223	234
LANCASHIRE—Red Hematite— Tons per man per annum .	264	260	286	268	285	273	311	280
SCOTLAND — Common Clay Band and Black Band Ironstone— Tons per man per annum .	145	146	194	185	197	195	211	215

* The output of ore in the United States is obtained by calculation, as the quantity raised is not given in the American Iron and Steel Association Reports. The yield of iron in the ore is roughly taken at 55 per cent. In the case of France, the average applies to two of the years (1881 and 1882), and in Belgium one year only is taken, namely, 1883.

From these figures and other data in my possession, I am disposed to think it probable that the average quantity of iron ore worked in the United Kingdom per individual engaged may be taken at 500 to 525 tons per annum.

Of the mines of the German Empire, those in Luxemburg most resemble the Cleveland, and I suppose the production per individual will be about the same. Of the total quantity of ore raised in 1882, viz., 8,263,000 tons, 2,476,000 tons were from the Luxemburg mines, and probably one million tons from Alsace, in all, say 3½ million tons from the two.

According to the returns, the effective duty of the German miners in that year (1882) was 213 tons raised per man by 38,783 men. Taking the output in the Luxemburg and Alsace mines to be 800 tons per man, we have only 133 tons per man per annum for the remainder of the ore worked in Germany.*

The only item in which the statistics prepared by the American Iron-Masters' Association appears deficient are those appertaining to the quantity of ore raised. I have received privately a statement from mines in the Lake Superior district, the most important one, at present, in the United States. From this it would appear that the average output is about 330 tons per man employed per annum. In the future the average produce of the American iron-mines may be materially affected by the increased quantity which will probably be afforded by the Southern States—Alabama, Georgia, and Tennessee, to which reference will hereafter be made.

The output of each individual engaged in the iron-mines of France was 351 tons in 1881, and 358 tons in 1882, 8,623 men being employed in the former and 9,438 in the latter year. Of the ironstone raised in France in each of these years (3,250,000 tons), about one-third was from the mines of Longwy and Nancy districts. The mineral thus obtained resembles that of Luxemburg. Unfortunately I was unable to get any information

* The figure (800) has been taken as being the same as the Cleveland, the beds of ironstone greatly resembling each other. At the same time, I question the foreign output being equal to the English.

respecting the work done by the men engaged in these mines, owing to the fact that many of them are employed partly in mining and partly in agriculture. Assuming, however, that working ironstone was a man's sole occupation, we would be safe in taking 800 tons per annum as the maximum result of his labours. Upon these assumptions it will be found that each individual of the remainder of the ore-mining population raised 282 tons per annum.

In respect to Belgium nothing need be said, for although in bygone years her blast-furnaces were kept employed almost exclusively in smelting native ores, the iron-mines of that kingdom are practically abandoned, as will be observed on referring to the table of workings, &c., given at p. 71. The imported mineral, judging by the average yield of pig iron, must consist chiefly of hematite, the remainder being from Luxemburg.

In what has preceded I have endeavoured to show that the quantities of ore each man engaged in the mines brings to the surface per annum in the different countries is as follows:—

United Kingdom.	Germany.	United States.	France.	Belgium.
500 to 525 tons.	213	330	357	Practically none worked.

Although, as formerly appears, there is not very much difference in the richness of the ores in these countries, the figures must not be accepted as the comparative value of the mineral itself, because this may be affected by the cost of labour, the distance of the furnaces from the mines, &c. &c. These are matters which will occupy our attention hereafter.

I do not propose pursuing the subject of the ore resources in other countries, because, as my object is merely to compare with our own the position of those nations which are competing with us in the markets of the world, enough has been said at present to serve my purpose.

If, as I think, the natural conditions under which the raw materials (coal, ore, and lime) exist in the United Kingdom are fully as good, if not better than those met with elsewhere, this position of equality or superiority can only be neutralised by

some counteracting circumstance or circumstances in their subsequent treatment.

The expenses attending the conversion of the ore into the metallic form may be divided under the following heads:—

(1.) Royalties payable to the owners of the soil, or their representatives.
(2.) National or local taxation.
(3.) Cost of transport of the materials and mining and manufacturing operations.

These will now be considered:—

ROYALTIES.—These not only differ in different districts, but they vary in mines situated in the same locality. These irregularities may have arisen from the leases having been granted when trade was prosperous or the reverse; or from the mining difficulties being greater in one case than in another; or from differences in the quality of the mineral; and lastly, from the geographical position of the field containing it.

It is not intended to deal with any extremes, but to take an average of what is usually paid in different districts.

In the United Kingdom the property of the minerals is, unless other arrangements have been entered into, vested in the owner of the soil; in any case the person working them has to pay for the right of so doing.

To prevent the mine-owner leasing large areas of ground, and leaving it unworked, *fixed rents* are charged whether any mineral is worked or not; such fixed rents being regarded as payments on account for future workings. The lease sometimes permits the lessee to set such payments against the mineral taken away during any period over which it runs. At other times this privilege lapses at fixed dates, as may be agreed to by those concerned. The amount involved in these fixed rents is sometimes very inconvenient to the lessee. The ironmaster may have to contend with adverse times, when the state of trade would suggest either a reduction of make or its entire dis-

continuance. He has, however, not only to face this fixed payment, but he has to keep his mines free from water, and the machinery, &c., in good repair. I could name cases where £20,000. or £30,000. a year would barely suffice to meet the expenditure under these two heads.

The royalty dues paid in Cleveland for ironstone are about 6d. per ton. In Lincolnshire and Northamptonshire they are sometimes double this sum, because, instead of expensive shafts and machinery being required, the mineral lies near the surface, with a covering of greater or less thickness of sand or rock. In such cases it is got by simple quarrying. Coal varies in different places, but 6d. to 1s. per ton may be regarded as common rates. A common rent for limestone is 1d. to 3d. per ton. In addition to these charges, the lessee has to pay double rent for all surface damage, and to restore the soil at the end of his lease or pay its value.

In Germany the ownership of coal and iron ore is vested in the State. The royalty paid on the former is two per cent. on the profits. I suppose that at a selling price of 6s. per ton, the profit will be such that 1½d. per ton will cover this payment. For iron ore nothing is paid for the right of working. No objection on the part of the owner of the soil is allowed to prevent the minerals on his property being worked, such prohibition being considered as inconsistent with the interests of the nation.

In the United States the ownership of the minerals goes with that of the surface, and as coal and iron ore lands have been, and still are, sold for a few pounds, or even shillings, per acre, the royalties on the minerals, like the agricultural value of the surface, cannot be compared with what is paid for similar property in older countries. Further on it will be explained that, notwithstanding this state of things, royalties are often as high in North America as they are in any part of Europe.

In France all ironstone, save a trifling amount which is of an alluvial character, and all coal since 1810, have been claimed by the State. Concessions to applicants are granted on an annual

payment of about 8s. per square kilometre (about 245 acres). In addition, a tax is levied not exceeding 5 per cent. on the profits. If the latter amounted to 2s. per ton the royalty would be below 1¼d. per ton.

In Belgium before 1830 the iron ore was the property of the State, when it was transferred to the owners of the soil, by whom leases are granted on payment of from 4⅜d. to 2s. per ton. Inasmuch, however, as very little ore is now worked in Belgium, the question of royalty is unimportant. Coal remains the property of the State. The rent on it is 1d. per annum per hectare (a little above two acres), with 2½ per cent. on the annual profits. This on an assumed profit of 2s. would be under ¾d. per ton.

The minerals in Spain also belong to the State, concessions being granted on nominal terms.

From the data already enumerated in reference to the royalties, it may be assumed that the charges are as follows:—

In Great Britain:

Pig iron per ton, Cleveland, 3s.; Cumberland and Lancashire, 6s. 3d.; Scotland, 3s., using clay ironstone, and from 5s. to 6s., using black band ironstone—the average being 4s. 10d. On iron ship plates 5s. 9d. will represent a common charge for royalty; and 3s. 8d. to 7s. 3d. on steel rails, according to the ore from which they are made.

In Germany:

6d. on pig iron; 1s. on iron ship plates; 8½d. on steel rails.

United States:

The royalties vary from nothing to 6s. or 7s. per ton, for reasons to be given hereafter.

France:

On pig iron, 8d.; on iron ship plates, 1s. 1½d.; on steel rails, 11d.

In the present depressed state of the iron trade in this country, while ironmasters and mine-owners are working at a rate which gives practically no profit to the capital employed, and in many cases results in a loss, it is widely felt as a grievance that the landowners to whom royalties are payable receive the full amount reserved by the leases.

It is contended that should the present low prices continue those engaged in mining in this country must be reduced to bankruptcy, and a great industry must be extinguished, unless the receivers of royalties are willing to abate something of their legal rights, which now give them about 3s. on every ton of the cheapest kinds of pig iron made, or very nearly ten per cent. on the gross price of the manufactured article.

Royalties on minerals resemble, in their relation to the cost of production and the price paid by the consumer, the rent paid by agricultural land. That is to say, a royalty will only be payable when the demand for minerals exceeds the supply which can be procured in the easiest and cheapest manner, and the theoretic royalty will be the difference in cost between the cost of production and placing in the common market of the more favourably situated mine and that which is most expensive to work, and which yet can be worked at a profit. But in practice most lessees of mines are in the enjoyment of a beneficial lease, not at a rack rent, for mining leases are necessarily usually for a longer period than agricultural tenancies, owing to the need of the lessee for security of tenure on account of the large amount of fixed capital required in opening up a new mine. Thus as a new mining district is opened up the more remote or poorer deposits in a growing trade will be leased possibly at as high a royalty as the richer or more accessible mines, which were leased when the prospects of the district were less assured. But even now the owners of minerals in the less favourably situated mines are forced in a losing trade to make concessions to their lessees, though they are able, if they hold out for their full legal rights, to see all the capital of the tenant made value-

less before the loss begins to fall on themselves in respect of the royalty.

The subject in question has been receiving some attention of late in the press, and the injustice, as it has been termed, has been remarked on, of the workmen having their wages reduced and the railway companies their rates lowered, while the landowners remain unaffected during the long-continued depression in the iron trade. The remedy recommended in some instances has been a drastic one, viz., confiscation of the landowners' rights. I have not, in my experience, met a single lessee who dissociates the right of his landlord to the minerals any more than he would question his title to the surface. As is known, when the profits were very high, the landlords had to be content with the same rents they received under a very different state of things. It has, however, to be remarked, that the present royalties were arrived at by previous experience of the value of the produce of the mines, and there is no doubt that had the present prices of iron been contemplated as possible when the leases were entered into, some provision would have been made for such a contingency. It would seem, therefore, open for consideration whether, by means of a sliding scale, the payments to the landlord should not be made dependent on the market value of the mineral, a system which, in some cases, has already been adopted.

With regard to confiscation itself, the only ground upon which it could be recommended would be, not for the advantage of the lessee, but for the good of the commonwealth. But in many, indeed I suspect in the majority of cases, both would prove illusory. Let us take the case of the Bilbao mines. The value of their produce was practically settled by the nature of the competition which they would have to encounter from the hematite mines in existence at the time the concession was granted. The Spanish Government handed over its rights to certain individuals without any reference to the value of the ore, or having any other object in view than those of attracting capital

to the place and of providing employment for its subjects. They who had been judicious and fortunate enough to be the first to embark in mining adventures there looked upon the affair from an entirely different point of view. A large tract of mineral property was transferred by the original holders of the concessions to new parties at a high price, who, under the conditions of the transfer, have no alternative but to charge a royalty, which never reaches the national exchequer of Spain. I met with many similar instances in the United States. The mines on Lake Superior are rich in them. Skilled geologists, with energetic minds, pushed on into this then unknown region, indeed so little known at the present day that I found the native Indians still living in its vast tracts of unclaimed land. One enterprising speculator purchased from the State a property of forty acres for a few thousand dollars. By him it was let to a second, who agreed to pay a royalty of 2s. per ton on the ore to the original purchaser, and the new owner, after an expenditure of £3000. to £4000., passed the property on to a third, who paid for the privilege of working the ore in addition to the royalty of 2s. per ton, the sum of £75,000., leaving thus a profit to the second holder of £71,000. or thereabouts.

Again, in Pennsylvania there is the Cornwall Mine, for which I was informed that the owners refused from the Philadelphia and Reading Railway Company a million sterling. I do not vouch for the accuracy of the sum, but I believe a very large amount was actually offered.

NATIONAL AND LOCAL TAXATION.—The income-tax, being a charge upon the profits, and not, properly speaking, an item of cost of production, is not included under the present section of manufacturing expenses.

On the ironstone leased previous to the Rating Act of 1874 the lessor pays one-half of the local rates, but in all other mining operations connected with the manufacture of iron, the whole of the charge under this head falls upon the lessees.

Judging by the experience of my own firm, which is of the usual kind in Cleveland, it appears that the local taxes of every kind on pig iron, including that paid at the mines, amounts to 5·86d. per ton, of which the ironstone lessor pays about one-sixth. On malleable iron and Bessemer or open-hearth steel the total charge for rates may be taken at 1s. per ton, which sum includes the payments made in respect to coal used in the process of conversion and those on the pig iron employed.

In Scotland I have returns from two firms who both give 9d. per ton as the amount payable on pig iron in respect to the charge under consideration, and a steel manufacturer gives 6·6d. per ton as the sum levied on his works. To this he adds 4d. per ton of steel for what has been paid by the colliery owner on the fuel he has used. Supposing foreign ore to be smelted in the blast furnaces, the total charge for rating purposes on steel may be taken at 1s. 6d. per ton, and 1s. 9d. when the pig is obtained from native ore.

From an ironwork in Westphalia, the payments, which include contributions to infirmaries and benefit societies, amount, on pig iron, when at full work, to 1s. per ton. At another, in Alsace Lorraine, the local rates do not, according to the information received, exceed one-half that paid at Middlesbrough.

In Belgium the rates (*taxes communales*) are very small—only ·135 francs, say 1·28d. per ton of pig iron, inclusive of that charged on the coal.

Of American local taxes I am without any information.

In Scotland great complaints are made of the effect of the Coal Mines Regulation Act of 1872, which, according to one return I have received, is made responsible for an addition of 3s. 4d. to the cost of making a ton of pig iron. There are so many changes taking place in connection with wages and other matters in conducting mining operations, that it is often very difficult to analyse, with correctness, the final results. Such an increase as that spoken of as having taken place in Scotland is

equivalent to about 8d. per ton on all the coal and ironstone required to make one ton of iron. According to the figures to which I have access, no such increase of cost is apparent in the county of Durham, where I question its amounting to one-fourth of the sum given me by the Scotch ironmasters.

There is one matter in connection with Imperial taxation which the mine-owners of the United Kingdom as a body regard as oppressive. A certain sum of money, usually a very large one, has to be expended in sinking the pits, &c., in order to reach the coal or ironstone. When the minerals are exhausted, all this outlay, with the exception of the machinery, which is only of the worth of old material, is irrecoverable. It is, therefore, obviously as much an expense on working every ton of mineral to which the expenditure has afforded access, as is the man's labour who mines the coal or ore. The Income-tax Commissioners, however, disregard these facts, and by the time the minerals are exhausted they have received income-tax on, it may be £100,000. to £200,000. on every pit, above that to which they, it is considered, are justly entitled.

TRANSPORT OF MATERIALS—MINING AND MANUFACTURING OPERATIONS. — The power of producing cheaply depends on the cost and efficiency of human labour. This remark applies with great force to an article like iron, in which, with the exception of the royalties and profit on railway carriage, the expense of manufacture consists almost entirely in wages paid to workmen. Every one who has had any experience in the work performed by his men knows, as might be expected, how close the connection is between efficient labour and food, which latter ought to be cheap and good. In former days, when low-priced labour abroad was spoken of, its cost was generally attempted to be explained by the low character of the nourishment upon which the workmen there were content to subsist. This is a mistake; badly fed men are never good workers; but this fact does not affect the proposition respect-

ing the importance of cheap food, provided it is of proper quality.

My own observations while on the Continent agree with those of all writers on the gradual rise in the cost of provisions there during the last thirty years or more. This may be partly accounted for by the increase of population, by the introduction of new branches of industry, and, lastly, by our free trade policy in this country, which, aided by improved modes of transport, has enabled us to reap part of the advantages flowing from the fertile soils of France, Germany, and other countries.

A French coal-owner gave me the result of his own personal experience, which I repeat as he told it. The figures are in French weights and currency, and apply to every tenth year:—

TABLE XXXV.

	1830.	1840.	1850.	1860.	1870.	1878.	Increase per cent. from 1830 to 1878.
	fr.	fr.	fr.	fr.	fr.	fr.	
Butcher meat per kilo.	0·62	0·75	1·01	1·06	1·34	1·66	167 per cent.
Butter per kilo. . .	1·50	1·55	1·74	1·86	2·57	3·04	102 ,,
Potatoes per hectolitre	2·33	3·12	4·34	4·25	4·06	4·82	107 ,,
Shoes per pair . . .	2·45	2·17	2·50	3·24	4·68	6·53	166 ,,
Coarse cloth per mêtre	4·16	8·05	7·56	8·20	7·68	7·12	71 ,,

I could multiply proofs to the same effect almost without end, from Germany and elsewhere, obtained by myself and observed by others, but this will probably be considered needless. I may remark, however, that the purchasing power of money in reference to provisions was never more favourable in Great Britain than it is now. Seeing that we are bringing from America and India together, about as much wheat as we grow ourselves, besides other articles of domestic consumption at a low rate of freight, and unhampered with import duty, and that other European nations are also importers, paying a little more for freight and often a duty besides, it is an indication that Great Britain is probably as well circumstanced as its neighbours in respect to the means of feeding its people.

With the increased cost of the means of subsistence abroad, as described, it is not surprising that foreign workmen should have demanded higher wages. In 1827 coalhewers could be had in France for 1s. 5½d. per day; in 1869 their pay had risen to 3s. 1¾d., and in the excitement of 1873 and 1874 it reached 3s. 9½d. per day.

The following figures, taken from the experience of a French colliery owner, illustrate the connection (one, however, that the English coal owner did not experience in 1873) between better pay and improved efficiency:—

TABLE XXXVI.

Coal Hewers' Wages.	1860.	1869.	1872.	1873.	1874.	1875.	1876.
Wages per week	s. d. 10/7½	s. d. 12/8¾	s. d. 15/7½	s. d. 17/2	s. d. 16/4½	s. d. 15/4¾	s. d. 16/1¼
Cwts. of coal worked per man per day	41·53	61·20	68·82	67·6	60	60	58·46

The following facts are taken from an official report respecting Belgian collieries in the province of Hainault:—

TABLE XXXVII.

	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.
Output per individual of the entire staff per annum, tons. . .	149	144	157	146	133	136	133	137	150	155
Wages per week per individual	s. d. 14/10½	s. d. 12/11	s. d. 16/0	s. d. 21/5	s. d. 18/2	s. d. 17/11½	s. d. 15/9	s. d. 12/8	s. d. 12/8½	s. d. 12/3¼
Price of coal at pit . .	8/9	9/1	10/9¾	17/4	13/2½	12/6	10/11½	8/10¾	8/0½	7/6½

At the collieries of an extensive firm in Westphalia, the average daily earnings of all the men engaged in working coal were as under:—

1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1878.	1879.
s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
2/4·92	2/6·72	2/8·16	2/11·74	3/3·39	3/3·72	3/0	2/8·77	2/5·16	2/3·36

The total weight of coal mined in Germany in 1875, and the weight raised per individual, is set forth in the following figures :—

TABLE XXXVIII.

		Raised per Individual.
	Tons.	Tons.
Silesia	10,444,364	240
Westphalia . . .	10,749,025	199
Rhineland . . .	11,645,014	203
Saxony	3,061,275	177
Sundries. . . .	1,391,025	131
	37,290,703	204

Underneath is the price of coal in Prussia, and the weekly earnings of the work-people, including women and children, in certain districts :—

TABLE XXXIX.

	1864.	1871.	1873.	1875.	1877.
	s. d.	s. d.	s. d.	s. d.	s. d.
Ruhr District	14/5	17/1	21/11	17/1	16/4
Saar District	13/7	16/5	20/10	16/8	16/3
Upper Silesia	12/7	16/8	18/5	15/9	13/1
Average	13/6	16/8½	20/4½	16/6	15/3
Price of coal in Prussia at the pit	5/9	6/11	10/9	7/6	5/7

In two English coal mines situate in North Durham the average earnings were, in 1850, 3s. 1·97d., and in 1881, 3s. 6·70d., with free house and coal. In these pits the hewers averaged 4·51 tons per shift, and the entire staff 2·06 tons. In two pits in South Durham the present pay amounts to 3s. 10d., with house and fire, and the average annual output per individual engaged is 443 tons. The coal-hewers, taken alone in the county of Durham, receive about 9d. per day above the average pay of the whole staff—say nearly 4s., with free house and fire.

In order to show the comparative cost of mining labour in

Great Britain with the foreign, I will give the average earnings of, and work performed by, the coal-hewers in a colliery in the county of Durham over a series of years embracing 1872 and 1873, when prices of coal were very high.

TABLE XL.

	1871.	1872.	1873.	1874.	1875.	1876.	1877.
Weight of coal worked . .	Cwts. 83·87	Cwts. 76·03	Cwts. 71·96	Cwts. 70·80	Cwts. 70·14	Cwts. 78·64	Cwts. 86·96
Daily earnings	s. d. 4/5·67	s. d. 5/7·40	s. d. 8/3·54	s. d. 6/10·65	s. d. 5/9·13	s. d. 5/10·16	s. d. 5/3·9
	1878.	1879.	1880.	1881.	1882.	1883.	1884.
Weight of coal worked . .	Cwts. 90·0	Cwts. 74·63	Cwts. 91·96	Cwts. 94·79	Cwts. 107·74	Cwts. 107·21	Cwts. 106·96
Daily earnings	s. d. 5/0·54	s. d. 4/4·42	s. d. 4/3·73	s. d. 4/10·2	s. d. 5/2·57	s. d. 5/3·53	s. d. 5/1·27

On going back to the year 1850 the earnings of the coal-hewers were only 3s. 10½d., and in 1847 only 3s. 4d. per diem.

The following were the average daily earnings of the entire staff of a colliery in Westphalia over ten years:—

1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.
s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
2/4·92	2/6·72	2/8·16	2/11·74	3/3·39	3/3·72	3/0	2/8·77	2/5·16	2/3·36

In order to compare these figures with the pay in a Durham colliery of all the men and boys employed, I give the following, obtained from an authentic source:—

1881.	1882.	1883.	1884.	1885.
s. d.	s. d.	s. d.	s. d.	s. d.
3/10·56	3/10·43	4/0·50	4/0·60	3/11·18

In contrasting the Durham earnings with those of Westphalia, sight must not be lost of the great decline in the value of coal and labour between 1873, 1874, and after 1877 down to the present day. In 1878 the Westphalian earnings were

2s. 3·36d. per day, against what, including house rent and fire, may be taken at about 4s. 9d. in England.

It has also to be remarked that fifty years ago the colliers spent twelve to fourteen hours per day in the pits, whereas now they are not above half this time underground.

If the amount of work cited, as performed by the Durham colliers, is compared with that of the French pitmen already given, it will be seen that the former is much in excess of the latter. Part of this is due to the difference between the two seams of coal in which the men were working, but I am strongly of opinion that the superior results of the English miner must be ascribed, in a great measure, to his better pay and better living.

In 1877 the miners in the iron ore pits in France, at Longwy and Nancy, were earning 3s. 3¾d. per day, and the labour on the ton of ironstone was almost exactly the same as that in Cleveland, where the average earnings were fully 1s. per day more.

At Luxemburg two men work and fill into waggons 10 tons of ironstone, for which they received in 1878 a price which, after finding their own powder and lights, left each man 3s. 2d. per day. To do this they were twelve hours underground. The Cleveland miners worked the same quantity, or rather more than 5¼ tons in eight hours, earning there 4s. 4d. to 4s. 6d. a-day, after paying for powder and lights.

Dealing with the mining class generally (coal and ironstone), in the north-eastern district of England, and disregarding any differences in the facility of extraction of the minerals themselves, I have estimated that their comparative cost in point of labour is approximately represented by the following numbers:

England.	Germany.	Belgium.	France.
100	95	124	103

The inference to be drawn from the amount of work performed and wages paid in Germany, France, and Belgium is, that as the price of coal rose the work-people were better paid for their

labour. The observations made respecting the price of food in France are equally applicable to Germany and Belgium, and it must be remembered that if the income of the miners increased so also did their expenditure, because food and clothing have been shown to have risen greatly in price during the last thirty years in these countries. The fact that the large importations of food, &c., from abroad into the United Kingdom have greatly lowered the price of the necessaries of life is too well known to require any further comment in its support. Instead, however, of the price of labour with us having fallen with the cost of living the contrary has happened.

Going from the smelting furnaces to the subsequent processes of converting the pig into malleable iron and steel, the same observations with regard to the cost of labour hold good, but not to the same extent. In both of these two branches, but particularly in the former, there are certain individuals in England and Scotland who earn very large wages, 20s. per diem and upwards, but these, out of the entire staff, are few in number, and their earnings are dependent on the extent of work produced, and on the fact that frequently they occupy the position of contractors, having other men in their employ as assistants.

The one guide for forming a correct judgment on the whole question is the money paid for labour on the finished article. Submitted to this test, I have rarely found that our malleable ironmakers were, everything considered, notably behind any foreign establishment.

It cannot, however, be pretended that there are not some branches of industry connected with the use of iron where cheaper labour does place foreign countries at an advantage as compared with our own, but I speak after one of the most competent judges I met with in Germany, who informed me that this was confined to cases where skilled labour entered largely into the production of the article. Thus in steam-engines and more complicated machinery, where less

mere muscular effort is required than in the ironworks, he considered that our dearer labour and shorter hours placed us at a disadvantage when brought into competition with themselves. On the other hand, I found puddlers, whose work is very severe, doing as much as our own. The following prices for this kind of labour were being paid in 1879 in England and in other countries:—

	s.	d.
England—Cleveland, with a bonus if they were worked full time	7	2
Rhenish provinces, 4/7 to 6/6—average of four works . .	5	6
Western Germany	4	10¼
Belgium, 4/2½ to 5/11—average of five works	5	1
France, north-east of, 5/9½ to 5/10¼—average of two works .	5	9¾

It must not be inferred that the differences in the price paid for puddling has always to be taken as a guide in estimating the cost of labour. Some kinds of pig iron are more easily puddled than others; thus in Belgium and elsewhere I have found the produce of a furnace one half greater than is the case in the forges at home. Again, however, this statement is liable to be misleading. The English puddler could, in some cases, if he would, do more work than he usually turns out, but practice has established six heats or charges as the proper quantity, and as soon as he finishes this he goes home, leaving his furnace for an hour or more doing nothing, while the foreign furnace is kept at work almost uninterruptedly.

Recently public attention has been drawn to iron and coal being sent from England to Norway and to Denmark, and used there in the construction of ships, at a cheaper rate than vessels of the same class could be built in our own country with the materials on the spot.

This statement was confirmed a year or two ago by a well-known shipbuilder in the North of England who visited the yard where the work was being carried on. From him I learnt that a vessel of 1250 gross register tonnage cost for labour

alone at least £850. less in Norway than would have been paid for a precisely similar one in England.

In answer to an inquiry I made in Belgium, the workmen engaged at a shipyard in that country were paid as follows:—

	s.	d.	
Joiners	3	2	per day.
Carpenters	3	11½	„ „
Blacksmiths	3s. 2d.,	3	11½ „ „
Platers	3	2	„ „
Rivetters	3	2	„ „
Fitters at machines	3s. 2d.,	3	11½ „ „

The average amount paid to the entire body of workmen was 2s. 11¾d. per day of ten hours.

A correspondent of the Newcastle *Daily Chronicle* writes (15th February 1886), that there is a great number of shipbuilding yards on the banks of the river Maas, near Rotterdam, where vessels are being built, on English account, for Japan and for Cape Colony. In these establishments there was no artisan, however skilled, earning more than one pound per week for sixty-three hours' actual work. In the marine-engine works the unskilled men were paid at the rate of 11s. 8d. per week, and the best paid skilled men at the lathes and planing-machines and at smiths' work, earn 23s. 4d. per week, and ordinary mechanics 21s. 6d. per week. According to the testimony of this authority the men are doing quite as much and quite as good work as is performed by our artisans in Great Britain.

In the matter of German workmanship, I would quote the opinion of one of our most distinguished engineers and an ex-president of the Institution of Civil Engineers. By this gentleman I was informed, in 1876, that a large quantity of iron bridge work he required for Holland was obtained at a cheaper rate from Germany than the offers received from England, and at the same time the workmanship was stated to be quite as good as, if not superior to, that furnished by English houses.

In Germany labour in the shipbuilding yards is also obtained upon much more favourable terms than those current in Eng-

land. The difference in cases where wages are paid by time and not by piecework amounts to 50 per cent., *i.e.*, for 20s. paid in Germany our builders have to pay 30s.

The great depreciation in the value of British shipping property has been referred to in these pages. As a natural consequence iron shipbuilders have to choose between closing their works or taking orders at prices which, I am assured, leave no profit. To meet the outgoings which are incurred whether the yard is idle or at work and to keep their staff together, they prefer the latter alternative, provided the men will submit to a reduction in their wages.

According to a statement in the newspaper (12th February 1886) already quoted, nine representative shipyards in the Tyne and Wear showed that the *average* earnings on the piece rates, current since the last reduction of the following classes of men belonging to the Boilermakers' Society, had been—

	s.	*d.*	
For platers	11	3¾	per day.
„ blacksmiths	12	0	„
„ rivetters	8	9½	„
„ caulkers	8	8	„

From these prices the employers are now asking a reduction of 10 per cent. to 12½ per cent., and 2s. per week off time wages.

Mr. William Gray of West Hartlepool informs me that he has just completed two vessels having a carrying capacity of 2850 and 3000 tons respectively, and he gives the following as the earnings of the men engaged on piecework—

	s.	*d.*	
Frame benders, shell and inside platers .	12	2	per day.
Rivetters	9	0	„
Caulkers and cutters	8	0	„

These are the average earnings of the three classes, but some of the best men were able, at the prices of the day, after paying their assistants, to make much higher wages than those just given.

Upon the two steamers in question some received the following:—

	s.	d.	
Frame benders	19	3	per day.
Platers	16	6	,,
Rivetters	12	8	,,

According to an estimate given me by Mr. Gray the average earnings of all the *men* employed in his shipyard, including ordinary labourers, over four weeks amounted to 6s. 8d. per day. He further states that whereas vessels which formerly received any damage abroad were patched up there and sent to England for complete repairs, now, in consequence of cheaper labour, British vessels, when within reach of a continental shipyard, are having the injury made good by the foreign shipbuilders.

It is, however, not only in the shipyard itself that the cost of constructing a vessel in Great Britain is placed at a serious disadvantage in the cost of labour as compared with that of Germany and Belgium, and to which France may be added. The same observation may with equal justice be applied to the manufacture of the iron out of which the ship is built. In the year 1879 I obtained from the different works statements of the daily earnings paid to what may be considered the skilled men in a plate-mill. The following is the result of my inquiries:—

	German Works. s.	d.	English Works. s.	d.
Head puddler	5	8	6	1
Second puddler	5	3½	3	6
Third puddler	4	0	none	
Boy puddler	1	7½	,,	
Puddle roller	5	1½	15	1
Shingler	5	3	22	9
Furnace men at plate mill	6	6½	16	1
Plate rollers, average of five men	4	6½	Head roller 41	1
Head shearer, average of eight men	5	3½	,, shearer 34	9

The enormous differences exhibited by these figures must not be accepted as the actual excess of cost in England as compared with Germany; firstly, because in certain branches of labour, such as enginemen, labourers, &c., the discrepancy is less in

amount than in the case of the instances given above; and secondly, the number of men employed is often larger abroad than with us.

I have endeavoured to compare the actual cost on a given amount of work, and below is given the result of my estimates:—

	Germany.	England.
PUDDLING MILL—		
Delivering materials	4·42	2·45
Engine and firemen	3·30	8·30
Puddlers	63·25	108·50
Shinglers	4·50	11·10
Bogey men, rollers, &c.	22·64	12·10
Sundry labour	1·89	2·55
	£100·00	£145·00
FINISHING MILL—		
Delivering materials	2·13	5·34
Enginemen and firemen	4·80	5·00
Furnace men	16·40	30·66
Piling iron, rollers, and shearmen . .	74·03	60·50
Sundry labour	2·64	8·50
	£100·00	£110·00

Having regard to the quantity of puddled iron required to produce a ton of plates, the net result will give the English price of labour about 25 per cent. above that of the German work. It has, however, to be borne in mind that the labour in England is only kept down to its present comparative point in the finishing mill by the great amount of work turned out, and that as soon as shipbuilding in Germany is carried on upon a sufficiently large scale, we may expect to see considerable economy in the wages which enter into the production of ship-plates.

As a further illustration of what has been said in reference to English and German wages at plate-rolling, according to a return in my possession, 72 men and boys at a mill in the North-East of England received on an average 7s. 9½d. per day, while 66 men and boys at a German mill were only paid 3s. 6d. per day. In each case the number of hands comprised the

entire staff of the finishing mill, the puddling forge not being included. The English mill, however, turned out three times as much work as the German, which would give an advantage of about 24 per cent. in favour of the former on this section of the work. This, however, is a state of things which would be entirely changed when the German manufacturer has to deal with orders of the same description as those now given by British shipbuilders.

No effort on the part of the wrought-iron manufacturers has succeeded in obtaining any material abatement from the last five items in the list of earnings already given, beginning at 15s. 1d. and ending at 41s. 1d. per day; and at the present moment (15th February 1886) the men in the shipyards of the North-East of England have been on strike for some weeks in preference to accepting the terms offered to them by their employers.

Looking back to the history of the development of the foreign iron trade, it would almost appear as if insufficient importance had been attached to its progress by the manufacturers of the United Kingdom. Certain it is that in our own extensions we have failed to realise in time the effect which the large additional powers of production on the Continent could not fail to exercise, and now are exercising, on our own export trade.

It would be well if those who are acquainted with the resources of other countries, as well as of their own, could convince the working-men who have entered upon the present conflict, of the serious, it may be the irreparable, injury they are doing themselves by the course they are pursuing. If they gain their object they perpetuate a system which in the long run will be detrimental to this country and to their own interests. In the meantime orders are being sent elsewhere, valuable time and wages are being sacrificed, not only by themselves, but other men not concerned in the dispute are thrown out of employment.

The only other matter in reference to the labour question of

Europe which calls for notice is that connected with the Bessemer steelworks.

Returns were made in 1879 and 1880 from English and German works, which showed that in the former, at the converting department, the rates varied from 4s. 6¾d. to 7s. 0½d. per day, the average of the whole being 6s. 2¼d.; whereas, in the latter, the prices paid ran from 2s. 0¼d. to 2s. 11½d., the average being 2s. 8d.

In the English rail mill the lowest wages paid was 3s. 2½d., and the highest 23s. 2d. per day against 2s. 6d., and 8s. 7d. in the German mill. The average earnings in the former being 5s. 3¾d. and 3s. 3d. per diem in the latter.

On comparing the relative amount of work done in each case, the relation between the two is estimated to be as follows:—

	England.	Germany.
Converters—		
Work performed per man, England taken as unity .	100	81·17
Cost of labour on ingots „ „ .	100	63·24
Average daily earnings „ „ .	100	43·24
Rail Mill—		
Work performed per man „ „ .	100	100·00
Cost of labour per ton of rails „ „ .	100	86·11
Average daily earnings „ „ .	100	61·18

These figures show a considerable advantage in favour of the German mill, which on the finished article may be taken to amount to a difference of 24 per cent. All this, however, and perhaps more, will be absorbed in the expense of placing the rails on board a ship for exportation.

The remarks just made are dictated by no indisposition to see industrious and skilful men paid as liberally for their labour as the work on which they are employed can afford. What is wished to emphasize is that they, like their employers, have to meet the competition of other nations in the open markets of the world. The British ironmaster and shipbuilder can only dispose of their produce on terms at least as favourable to the purchaser as those offered by the foreign manufacturer, and for a like reason the British workman, in the long run, will be

unable to obtain higher pay for *the same amount of work* than the foreign artisan and labourer are willing to accept. In the case I have put the interests of the two cannot be dissociated.

I have compared the wages of the year 1850 with those of 1874 and 1881 in certain other trades, and I do not think there is any material change between the last mentioned year and the present time. These are given in Table XLI.

TABLE XLI.

	Increase as compared with 1850.	
	1874.	1881.
	Per cent.	Per cent.
Fitters and machine men . . .	34·99	18·58
Blacksmiths	41·08	23·24
Strikers to blacksmiths	30·71	21·95
Joiners	50·94	39·62
Bricklayers	50·94	40·12
Average	41·43	28·70

Notwithstanding the alleged disadvantage of position we are supposed to occupy as manufacturers of machinery, there is no country which exports a larger value, brought under this head in the Government statistical abstracts, than our own, and which, on reference to page 27, will be seen had increased in value from about 5½ million sterling in 1870 to above 13 millions in 1884. In what articles this great increase has arisen, it is to be regretted, the official returns do not enable us to ascertain.

Speaking generally of the cost of mechanics, it is usually admitted by foreign manufacturers, that labour with them for the same amount of work performed is 20 per cent. cheaper than with us, and I believe that the cost of living is usually very nearly the same here as on the Continent. This, I think, takes into the account the fact that abroad ten hours constitute a day's work against nine in this country.

Between 1850 and 1884 the pay of the workmen in the chemical manufactories on the Tyne rose 37½ per cent.

The subjoined list contains the weekly earnings of the mechanics and day labourers at one of the largest of these works since the year 1840 :—

TABLE XLII.

Year.	Blacksmiths.	Millwrights.	Bricklayers.	Joiners.	Labourers.
	Per Week.	Per Week.	Per Week.	Per Week.	Per Week.
	s. d.	s. d.	s. d.	s. d.	
1840	20 0	21 0	20 0	18 0	12s. to 13s.
1850	22 0	23 0	22 0	20 0	14s.
1855	24 0	25 0	24 0	22 0	14s. to 15s.
1860	26 0	27 0	26 0	24 0	16s. to 18s.
1872	28 0	30 0	29 0	28 0	20s.
1873	32 0	32 0	32 0	32 0	20s. to 22s.
1874	32 0	32 0	32 0	32 0	22s. to 24s.
1875	32 0	32 0	36 0	36 0	20s. to 22s.
1876	32 0	32 0	36 0	36 0	22s. to 24s.
1877	30 6	30 6	34 0	34 0	20s. to 22s. 6d.
1878	28 0	28 0	30 0	30 0	18s.
1879	26 0	26 0	28 0	28 0	17s.
1880	27 6	27 6	29 6	27 6	18s.
1881	30 0	30 0	29 6	29 6	18s.
1882	30 0	30 0	29 6	29 6	18s.
1883	31 6	31 6	29 6	29 6	18s.
1884	31 6	31 6	29 6	29 6	18s.
1885	27 6	28 6	28 0	28 0	18s.

Note.—Up to year 1871 a week's work consisted of 61 hours, and after that period of 54 hours.

The only other country which it will be necessary to consider in respect to the food and labour question is the United States.

In some years there is imported into the United Kingdom alone, collectively, nearly 8½ million tons of provisions of different kinds—grain, flour, animals, fish, lard, dead meat, and potatoes. A very considerable proportion of these articles is brought from the United States, upon which, in many cases, the carriage overland for 1000 miles has to be paid, added to the sea freight from the American ports to our own. The last thing which, under these conditions, might be expected, would be, that the American workmen, almost universally, should be charged higher prices for the necessaries of life than is the case with the labourers and artisans in England. Such, however, is the fact, which I am

able to verify as the result of my own inquiries when in the United States in 1874 and 1876; and Dr. Young, an American statistician, quotes the following figures for 1872 in illustration of the fact:—

TABLE XLIII.

Prices charged in Massachusetts.		Pennsylvania.	Great Britain.
	s. d.	s. d.	s. d.
Flour, per barrel.	36 0	31 8	33 0
Beef, per lb.	0 11	0 8½	0 9½
Mutton „	0 9	0 8	0 8
Lard „	0 9	0 8½	0 8
Cheese „	0 10	0 9½	0 9

So far as I know, a similar state of things still prevails as regards the two countries.

It will be perceived that, according to these quotations, the American workman was paying about 10 per cent. more for his provisions than the Englishman, but the earnings of the two in no way harmonised with this mere difference in the cost of living.

Upon the occasion of my visits among the mines and iron-works in the United States, the coal-miners were being paid from 8s. to 13s. per day; while those in the county of Durham, inclusive of a charge for house-rent and firing, were receiving 6s. 8d.

TABLE XLIV.

		North of England.	United States.
		s. d.	s. d.
Fitters and lathemen	(average)	5 1½	8 8½
Blacksmiths	„	5 5½	8 9½
Blacksmiths' strikers	„	3 4½	5 6
Joiners and carpenters	„	5 0	8 4
Bricklayers	„	5 0	10 7

At the blast furnaces the difference between the two countries was not of a very marked character.

For puddling iron the average price in 1874 was 10s. 10d. per ton in Cleveland and Staffordshire. In the United States,

the lowest I heard of was 18s. 10d. in the Susquehanna Valley, and the rate varied from this to 24s. 6d. in Tennessee.

In 1880 we were paying 8s. for puddling in England, while in the Lehigh Valley the rate was 18s. 9d. per ton.

In the remaining branches of labour in the iron trade, the differences were much less considerable; but this, generally speaking, arose from the English roller and mill furnace-man doing more work than was performed under similar circumstances in America.

It may be interesting to know the relation which English agricultural labour in our mining districts bore to that of the Western States, from which our large food supplies are brought, and which offer so extensive a field for employment to those emigrating from Europe. In 1880 the farm labourers in Cleveland were receiving 3s. per day and in America the pay was 4s. At that time I estimate that the head puddler in England was making 7s. 9d. per day, or 2·58 times that of the agricultural labourer. In the Lehigh Valley the chief puddler was getting for himself 15s. 7½d., or nearly four times that paid to the agriculturist.

It is clear that so long as these great differences exist between the old and the new worlds, the latter cannot take any important place in the exportation of such articles as pig iron, steel, or malleable iron.

At the same time we have before us the fact, already mentioned in these pages, that there is annually sent out from the United States machinery, estimated from its value, at something like 170,000 tons, into which their dear labour largely enters. Whether the hold they have thus got of the markets of the world is due to superiority of quality, or to ingenuity of invention, or it exists for the same reason that induces the German iron-makers to export iron and steel, I am unable to say. The nature of this reason in the case of Germany, as well as costs of labour at the blast furnaces, &c., in America, will be referred to hereafter.

The head of manufacturing operations necessarily includes the application of those lessons taught by scientific research. In Great Britain there are to be found instances of highly educated men attached to the laboratories now so common in our larger ironworks; but I am not sure whether chemists of the higher class are not more frequently met with on the continent of Europe than in British establishments.

It is impossible to over-estimate the advantages obtained by scientific training, not only for the purpose of pursuing what is really good in theory, but in rejecting what is absolutely fallacious. With a little more learning than is frequently possessed by a crowd of patentees, much money and some time would have been saved to British as well as to foreign speculators. At the same time we cannot fail to be struck with the good fortune which has attended the efforts of many inventors, particularly those of Great Britain, in this branch of industry, long before the value of applied science was recognised as it now is. Neilson conceived the idea of heating the blast before admitting it into the furnace. This simple change in smelting iron turned out so lucrative that in an action for infringement of his patent he received more than £100,000 in the shape of damages, probably the largest sum ever paid for such a purpose. What his reasons were for this preliminary heating of the air it is difficult to conceive, for there was no ground for believing that a given amount of heat conveyed in the blast could be more efficient than the same quantity of heat evolved by burning fuel in the furnace itself. Notwithstanding this consideration, a very important saving in coal resulted from Neilson's invention—a saving which, for reasons now well understood, far exceeded that required to heat the blast which entered the hearth. The blast furnace itself, the conversion of the pig iron into malleable iron—first in the low hearth, and subsequently by means of the puddling furnace—were discoveries made by what may be regarded as patient gropings in the dark, for certainly there was no information on the subject capable of being afforded by the

science of the day. And now, if any one pretends that foreign iron manufacturers are greater adepts in science than those in this country, we must leave him to account for the fact that the world owes more to the British than to any other nation for the progress which has been made in this department of metallurgical practice.

It is not, however, British iron manufacturers who have always profited most by British inventions. At the period of Neilson's invention no country could approach Great Britain in the cheapness with which coal was obtained. It follows, therefore, that the economy to foreign smelters was as much greater than to British, as the coal of the former was dearer than that of the latter. Hence any reduction in the quantity of coal required in the process diminished *pro tanto* the comparative advantage enjoyed by Great Britain. Similarly, although from a different cause, the *basic process* has proved of greater service to the German and French ironworks than to the country in which it was invented. As an example, cheap as the Cleveland ironstone is delivered on the Tees, pig iron can be made from Spanish ore for about 10s. a ton above that got from native ironstone. This sum represents something like the extra cost of the basic treatment, so that practically, at the present day, the steel-maker at Middlesbrough is little, if any, better situated than he was before the process was introduced.

The length of land-carriage on the sea-borne ore to certain continental iron works created a difference of 20s. to 30s. per ton in the cost of the two kinds of iron, the hematite used for steelmaking being, of course, the dearer. Thus, while the French have a margin of 20s. to 30s. per ton, out of which they can meet the expenses of the basic treatment of local ores, our own manufacturers had little or no margin whatever. In Rhenish-Prussia and Belgium the difference in cost between the two kinds of pig iron is much less than it is in the interior of France, but the margin is greater than it is in England.

This accounts for the much greater scale upon which this new discovery has been put in practice abroad than with ourselves.

With men well educated and engaged on a fairly large scale abroad in smelting and rolling operations, the possession of suitable machinery and appliances in the various departments is no more than might be expected. At the same time, no practical ironmaster in Germany, France, Belgium, or in the United States will deny that Great Britain has contributed more than its share to what belongs to the purely mechanical branch of ironmaking. In a recent publication from Her Majesty's Charge d'Affaires at Dresden, it is asserted that the blast furnaces on the Rhine have displaced those on the Tees from the foremost position they have held for some years. With many opportunities of seeing and hearing what has been achieved abroad and what is doing at Middlesbrough, I am at a loss to understand the ground upon which such a statement rests. The great object in smelting iron is to reduce the consumption of fuel, and having regard to the ore treated, and to the conditions generally, the theoretical quantity required for the process is very little exceeded in the best Middlesbrough furnaces. It is true in Luxemburg and elsewhere that the individual make of a furnace is larger than on the Tees. This may be partly due to the natural qualities of the ore, but even with this advantage, I doubt the economy of striving after an excessive production in point of quantity.

To some extent the cost of labour on the ton of iron may be accepted as an index of the general fitness of the establishment for the work done. Judged by this criterion, partly owing to the excellence of the arrangements for avoiding human agency, and partly owing to the geographical position of the raw materials, I have seen no smelting works in the old world or new which could compare with the Middlesbrough practice. If those in any foreign country are equal—I will not say superior—to it, a change must have been effected since my visits and since I have received foreign visitors, who all remark on the compara-

tively fewer hands employed at Middlesbrough than in their own country. To some extent this has to be attributed to the efficiency of our better fed men, a fact which I have heard generally admitted abroad.

In comparing the cost of railway carriage in Great Britain with that of other nations, there are two questions which suggest themselves—is the work for like distances done as cheaply with us as elsewhere, and are our minerals in relation to each other and to the markets as favourably placed, geographically, as they are in other countries?

My own inquiries on the Continent of Europe, and in the United States, justify the assertion that foreign iron manufacturers, as a rule, possess no advantage over ourselves in these respects. Sir Bernhard Samuelson, Bart., M.P., has recently reported to the Chambers of Commerce in the United Kingdom the result of his visits to the railways in Germany, Belgium, and Holland. So far as iron ore, coal, and coke are concerned, his opinion appears to agree with my own. The actual rates paid are tabulated in his statement, and for convenience of reference, in case of need, they are given below:—

STATEMENT OF RATES charged by BRITISH RAILWAYS ON CERTAIN ARTICLES, and of what those Rates would be if charged according to the TARIFFS OF GERMANY, BELGIUM, AND HOLLAND.

IRON ORE.

In the Cleveland district the average rate for transport, including waggon hire, for distances of 11 to 21 miles, per ton per mile, varies from	0⅝d. to 1d.
Same distance, according to German tariff, would be	1·14d.
Do. do. Belgian do. do.	1·2d.

No Blast Furnaces in Holland.

The above British rate is after the deduction of a temporary allowance of thirteen per cent.	*s.*	*d.*
Northamptonshire to Derby, British rate per ton	3	2
Same distance, according to German tariff, would be	3	0
Do. do. Belgian do. do.	3	6

No Blast Furnaces in Holland.

IRON ORE—*continued.*	s.	d.
Northamptonshire to Great Bridge (Staffordshire), British rate per ton	3	2
Same distance, according to German tariff, would be . . .	3	3
Do. do. Belgian do. do. . . .	3	8
No Blast Furnaces in Holland.		
Do. Sheffield, British rate per ton	3	9
Same distance, according to German tariff, would be . . .	3	11
Do. do. Belgian do. do. . . .	4	0
No Blast Furnaces in Holland.		

COKE.

South Wales to Darlaston, British rate per ton	7	3
Same distance, according to German tariff, would be . . .	6	0
Do. do. Belgian do. do. . . .	4	7
No Blast Furnaces in Holland.		
Hedley Hill Collieries to Frodingham, British rate per ton . .	6	10
Same distance, according to German tariff, would be . . .	5	6
Do. do. Belgian do. do. . . .	4	4
No Blast Furnaces in Holland.		
Dodworth Colliery to Wellingborough, British rate per ton . .	5	3
Same distance, according to German tariff, would be . . .	5	2
Do. do. Belgian do. do. . . .	4	3
No Blast Furnaces in Holland.		
Thorncliffe Colliery to Wellingborough, British rate per ton . .	4	9
Same distance, according to German tariff, would be . . .	4	11
Do. do. Belgian do. do. . . .	4	1½
No Blast Furnaces in Holland.		
Howden Colliery to Wellingborough, British rate per ton . . .	9	1½
Same distance, according to German tariff, would be . . .	9	2
Do. do. Belgian do. do. . . .	5	10
No Blast Furnaces in Holland.		

COAL AND COKE.

Adelaide Colliery to Newport, in Cleveland, British rate per ton .	1	5½
Same distance, according to German tariff, would be . . .	1	8
Do. do. Belgian do. do. . . .	2	0
No parallel case in Holland.		
Etherley Colliery to Newport, in Cleveland, British rate per ton .	1	7¼
Same distance, according to German tariff, would be . . .	1	11
Do. do. Belgian do. do. . . .	2	2
No parallel case in Holland.		
Copley Colliery to Newport, in Cleveland, British rate per ton . .	1	10¼
Same distance, according to German tariff, would be . . .	2	1
Do. do. Belgian do. do. . . .	2	5
No parallel case in Holland.		
Hedley Hope Colliery to Newport, in Cleveland, British rate per ton	2	0
Same distance, according to German tariff, would be . . .	2	4
Do. do. Belgian do. do. . . .	2	7½
No parallel case in Holland.		

LIMESTONE.

	s.	d.
Bishopley (Weardale) to Newport, in Cleveland, British rate per ton	1	11½
Same distance, according to German tariff, would be . . .	2	6
Do. do. Belgian do. do. . . .	2	9
No parallel case in Holland.		
Raisby Hill to Newport, in Cleveland, British rate per ton . .	1	4
Same distance, according to German tariff, would be . . .	1	8
Do. do. Belgian do. do. . . .	1	10
No parallel case in Holland.		

The above British rates to Cleveland are after the deduction of a temporary allowance of thirteen per cent.

These foreign rates for coal, &c., are applicable not only to manufacturing purposes, but to all lots of not less than ten tons. Consequently the household, or so-called Landsale, coal, which, on certain lines in this country, is charged at very much higher rates, has the benefit of the low tariffs in Germany and Belgium.

COAL.

Bestwood to Boston, British rate per ton per mile. *Home Trade*	1·09d.	
Waggon hire .	0·12d.	
		1·21d.
Same distance, according to German tariff, would be . . .		0·69d.
Do. do. Belgian do. do. . . .		0·75d.
Do. do. Dutch do. do. . . .		0·76d.
Do. Boston, British rate per ton per mile. *Export* . .	0·51d.	
Waggon hire .	0·12d.	
		0·63d.
Same distance, according to Belgian tariff, would be . . .		0·34d.
No German or Dutch port so near the collieries.		
Do. Lynn, British rate per ton per mile. *Home Trade* .	0·67d.	
Waggon hire .	0·12d.	
		0·79d.
Same distance, according to German tariff, would be . . .		0·59d.
Do. do. Belgian do. do. . . .		0·59d.
Do. do. Dutch do. do. . . .		0·60d.
Do. Lynn, British rate per ton per mile. *Export* . .	0·38d.	
Waggon hire .	0·12d.	
		0·50d.
Same distance, according to Belgian tariff, would be . . .		0·31d.
No German or Dutch port so near the collieries.		
Do. Sleaford, British rate per ton per mile . . .	1·38d.	
Waggon hire .	0·12d.	
		1·50d.
Same distance, according to German tariff, would be . . .		0·77d.
Do. do. Belgian do. do. . . .		0·87d.
Do. do. Dutch do. do. . . .		0·95d.

COAL—*continued.*

Bestwood to Grantham, British rate per ton per mile	1·39d.	
Waggon hire	0·12d.	
		1·51d.
Same distance, according to German tariff, would be		0·89d.
Do. do. Belgian do. do.		0·96d.
Do. do. Dutch do. do.		1·14d.
Do. London, British rate per ton per mile	0·46d.	
Waggon hire	0·06d.	
		0·52d.
Same distance, according to German tariff, would be		0·52d.
Do. do. Belgian do. do.		0·36d.
Do. do. Dutch do. do.		0·47d.
Do. Brighton, British rate per ton per mile	0·33d.	
Waggon hire	0·07d.	
		0·40d.
Same distance, according to German tariff, would be		0·49d.
Do. do. Belgian do. do.		0·31d.
Do. do. Dutch do. do.		0·44d.
South Yorkshire to Brighton, British rate per ton per mile	0·31d.	
Waggon hire	0·08d.	
		0·39d.
Same distance, according to German tariff, would be		0·49d.
Do. do. Belgian do. do.		0·32d.
Do. do. Dutch do. do.		0·44d.
Do. London, British rate per ton per mile	0·45d.	
Waggon hire	0·06d.	
		0·51d.
Same distance, according to German tariff, would be		0 51d.
Do. do. Belgian do. do.		0·37d.
Do. do. Dutch do. do.		0·48d.

	s.	*d.*
Plumptree Colliery to Wellingborough, British rate per ton	2	9
Same distance, according to German tariff, would be	3	8
Do. do. Belgian do. do.	3	8
Do. do. Dutch do. do.	3	10
Shipley Colliery to Wellingborough, British rate per ton	2	7
Same distance, according to German tariff, would be	3	7
Do. do. Belgian do. do.	3	8
Do. do. Dutch do. do.	3	10

PIG IRON.

Cleveland to Durham, British rate per ton	2	11
Same distance, according to German tariff, would be	2	1
Do. do. Belgian do. do.	2	3
Do. do. Dutch do. do.	2	0

PIG IRON—*continued.*	s.	d.
Cleveland to Leeds, British rate per ton	5	1
Same distance, according to German tariff, would be	3	5
Do. do. Belgian do. do.	3	7
Do. do. Dutch do. do.	3	5
Do. Manchester, British rate per ton	8	4
Same distance, according to German tariff, would be	4	11
Do. do. Belgian do. do.	4	2
Do. do. Dutch do. do.	4	11
Do. Birmingham, British rate per ton	11	3
Same distance, according to German tariff, would be	7	10
Do. do. Belgian do. do.	6	2
Do. do. Dutch do. do.	6	11
I believe a slight reduction has been made from the above British rate since it was quoted.		
Northamptonshire to Sheffield, British rate per ton	7	2
Same distance, according to German tariff, would be	4	5
Do. do. Belgian do. do.	3	11
Do. do. Dutch do. do.	4	2
Do. Manchester, British rate per ton	8	9
Same distance, according to German tariff, would be	5	2
Do. do. Belgian do. do.	4	3
Do. do. Dutch do. do.	5	0
Barrow to Birmingham, British rate per ton	10	9
Same distance, according to German tariff, would be	6	1
Do. do. Belgian do. do.	4	7
Do. do. Dutch do. do.	5	8
Do. Sheffield, British rate per ton	7	4
Same distance, according to German tariff, would be	5	8
Do. do. Belgian do. do.	4	5
Do. do. Dutch do. do.	5	6
Kettering to Wolverhampton, British rate per ton	5	10
Same distance, according to German tariff, would be	3	8
Do. do. Belgian do. do.	3	8
Do. do. Dutch do. do.	3	6
(Query)—Has there been a very recent slight reduction from the above British rate?		
Wellingborough to Wolverhampton, British rate per ton	5	10
Same distance, according to German tariff, would be	3	11
Do. do. Belgian do. do.	3	9
Do. do. Dutch do. do.	3	8
(Query)—Has there been a very recent slight reduction from the above British rate?		
Whitehaven to Tipton, British rate per ton	11	8
Same distance, according to German tariff, would be	7	11
Do. do. Belgian do. do.	5	3
Do. do. Dutch do. do.	7	1

PIG IRON, &c.—*continued.*	s.	d.
Barrow-in-Furness to Tipton, British rate per ton	10	6
Same distance, according to German tariff, would be	6	7
Do. do. Belgian do. do.	4	9
Do. do. Dutch do. do.	6	1

BAR IRON, &c.

Brettel Lane to Liverpool, British rate per ton	11	0
Same distance, according to German tariff, would be	8	8
Do. do. Belgian do. do.	6	8
Do. do. Dutch do. do.	8	3
Do. Hull, British rate per ton	14	4
Same distance, according to German tariff, would be	11	1
Do. do. Belgian do. do.	7	3
Do. do. Dutch do. do.	9	5
Do. Paddington, British rate per ton	15	0
Same distance, according to German tariff, would be	9	4
Do. do. Belgian do. do.	6	10
Do. do. Dutch do. do.	8	7
Do. Manchester, British rate per ton	11	6
Same distance, according to German tariff, would be	7	0
Do. do. Belgian do. do.	6	4
Do. do. Dutch do. do.	7	3
Do. Nottingham, British rate per ton	10	0
Same distance, according to German tariff, would be	6	2
Do. do. Belgian do. do.	6	1
Do. do. Dutch	6	6
Do. Edinburgh, British rate per ton	20	0
Same distance, according to German tariff, would be	18	8

No quotations for this distance within Belgium and Holland.

Note.—For distances beyond the frontiers of Belgium and Holland the rate would be compounded of the respective local rates of the two countries, or of those countries and Germany.

North Staffordshire to Liverpool, British rate per ton	7	6
Same distance, according to German tariff, would be	4	8
Do. do. Belgian do. do.	5	0
Do. do. Dutch do. do.	4	8
Do. London, British rate per ton	13	4
Same distance, according to German tariff, would be	9	10
Do. do. Belgian do. do.	6	4
Do. do. Dutch do. do.	8	8
Newcastle to Darlington, British rate per ton	3	9
Same distance, according to German tariff, would be	3	1
Do. do. Belgian do. do.	3	10
Do. do. Dutch do. do.	3	4

IRON WIRE.	Packed.		Unpacked.	
	s.	*d.*	*s.*	*d.*
Birmingham to London, British rate per ton . . .	24	4	15	2
Same distance, according to German tariff, would be	10/4 to 11/2		8	6
Do. do. Belgian do. do.	8	11	8	11
Do. do. Dutch do. do.	8	2	8	2
Do. Liverpool, British rate per ton . . .	18	10	12	2
Same distance, according to German tariff, would be	9/2 to 10/–		7	8
Do. do. Belgian do. do.	8	6	8	6
Do. do. Dutch do. do.	7	9	7	9
Do. Hull, British rate per ton	25	0	17	6
Same distance, according to German tariff, would be	11/7 to 12/7		9	6
Do. do. Belgian do. do.	9	4	9	4
Do. do. Dutch do. do.	8	7	8	7
Do. Glasgow, British rate per ton	34	4	26	8
Same distance, according to German tariff, would be	22/11 to 25/2		18	4
No quotation for this distance within Belgium and Holland.				
Do. Manchester, British rate per ton . . .	16	10	10	2
Same distance, according to German tariff, would be	8/5 to 9/1		7	0
Do. do. Belgian do. do.	8	2	8	2
Do. do. Dutch do. do.	7	3	7	3
Do. Coventry, British rate per ton. . . .	8	8	5	0
Same distance, according to German tariff, would be	3/2 to 3/5		2	11
Do. do. Belgian do. do.	3	6	3	6
Do. do. Dutch do. do.	3	3	3	3

The actual sums paid for transport of the raw materials to the blast furnaces, per ton of iron made, differ considerably according to the district in which the smelting operations are carried on. Having regard, however, to the fact that this item of the cost is often nearly 25 per cent. of its present selling price, it is of the utmost importance that the service should be performed as cheaply as possible.

In Cleveland the cost of carriage of raw material on a ton of iron at the rates charged by the North-Eastern Railway will vary from 7s. to 8s., which includes the use of waggons of such excellent construction that they are emptied at the least possible expense to the consignee. For some time past this company, which has exclusive possession of the iron district, have allowed a rebate of 1 per cent. for every reduction of 1s. on the price of pig iron below 45s. At the present time this concession is equivalent to nearly one shilling per ton of pig iron. On the other

hand, as pig iron rises above 46s., a similar addition (1 per cent.) is made to the rates until it reaches 55s., when it ceases. Many of the ironworks in Cleveland, being placed on the river Tees, are enabled to ship the iron on board vessels of 2000 tons without further charge for railway dues.

In South Wales, at a point half way between the centre of the coalfield and the coast, the cost of conveying fuel and seaborne ore is 3s. 3d. to 4s. on the ton of pig iron. To this 2s. to 2s. 6d. per ton must be added in case it is required to put the metal on board ship.

In Scotland the charge for railway rates runs from 4s. 2d. to 5s. per ton of iron. The cost of shipping it at Glasgow may be taken at 2s. 6d. per ton.

The Lincolnshire furnaces are still, to some extent, supplied with coke from the South Durham coalfield, at a cost of about 6s. for carriage, which would bring up the total charge for carriage of raw material to about 7s. 6d. per ton of iron produced.

Recently large quantities of coke are being taken from South Yorkshire to the Lincolnshire iron furnaces, the distance being about 45 miles, instead of 112 as from South Durham. The rate on this coke is only 1s. 11d., but the quality being inferior to that of that from Durham more is required, and the dues, including the cost of transport on ironstone, will amount to 3s. 9d. or 4s. on the ton of pig iron. The actual charge on the produce of a furnace will depend on the proportions used of the Durham and Yorkshire fuel.

Cumberland and North Lancashire draw their supplies of fuel almost exclusively from the Durham coal-field, paying something under 10s. on the ton of pig iron, including the dues on the ore and limestone.

South Staffordshire brings a large proportion of its ironstone from Northamptonshire. The remainder consists of hæmatite from Lancashire and Cumberland, and of Black Band from North Staffordshire, used with a certain proportion of the ironstone of the district. The cost of transport on the minerals

varies from 7s. to 12s. 6d. per ton of iron made, but I believe the railway's rates have been recently reduced, by which the sum just mentioned will be correspondingly affected.

In North Staffordshire the furnaces are situate in a coalfield which supplies both fuel and ore—chiefly Black Band—hence the cost of transport on the raw materials is low, say 3s. to 4s. per ton of pig iron.

At the French furnaces situated near the mines in the vicinity of Nancy, the cost of transport of ore to the smelting-works was about 7d. to 1s. per ton. It yields 34½ per cent. instead of 30 to 31 per cent. like the best in Cleveland. Coke was brought by canal partly from the French coalfield at Anzin, at a cost of 7s. 1½d. for carriage over 277 miles. The remainder was German coke of inferior quality from Saarbrück, also brought by canal a distance of 61½ miles at a cost of 2s. 9½d. for conveyance, and from Ruhrort, a distance of 217 miles. German coke pays an import duty of 1s. 1½d. per ton. The cost for transport on materials may be averaged at 9s. to 10s. 6d. on the pig. At the period of my visit in 1878 the coke was costing 18s. to 22s. per ton —say 14s. to 14s. 9½d. at the ovens, the price in South Durham being then 10s. 6d. at the ovens. The distance from the sea prevents a great export trade, the carriage to Antwerp being 12s. a ton. Many of the works, such as the Creusot and those at St. Etienne, bring large quantities of African and Italian ores, which are landed at Marseilles, the former works being about 240, and the latter 140 miles, from the port, and the charge will be about 10s. and 7s. respectively on the ton of ore.

At Luxemburg, partly Belgian and partly coke from Rhineland is used in the blast furnaces. The carriage of the former was 5s. 2½d. and the latter 8s. 10d. in 1878 for 217 miles, the price at the ovens being 12s. and 9s. 7½d. respectively. The yield of the ore is 33 per cent. The cost of transport on the materials used for a ton of iron may be taken at about 9s., including that on the ironstone, and if the pig iron has to be conveyed to the Rhenish and Westphalian malleable ironworks, the total sum

paid to the railway companies will be about 17s. 6d. to 18s. per ton. The carriage on pig iron to the Belgian malleable works is 6s., making the total cost for transport on coke from Belgium, on ore from the mines and on pig iron as back carriage, about 15s.

In the neighbourhood of Metz the coke was being brought from Westphalia at a cost of 9s. 6d. for railway carriage, costing, including delivery, about 17s. 6d. at the works. The whole expense of transport per ton of iron amounts to 11s. or 12s. Any export business done from this district must be carried on under very disadvantageous conditions, for the carriage to Antwerp, their usual shipping-place, is about 12s. per ton.

Of all the seats of the German iron trade, those on or near the Rhine offer to this country the greatest amount of competition. Unless very considerable improvements have been made in the blast furnace arrangements since I visited the works, I am unable to see, even with their cheap coal, that they can make the foundry or ordinary pig iron for puddling within several shillings above the present selling price of Cleveland mine iron.* As regards hematite iron made from Bilbao ore, the conveyance of the mineral from Rotterdam to the works costs 4s. per ton, so that this item alone will make a ton of Bessemer pig iron cost 8s. above what the same iron, in some cases, can be produced at furnaces on the Tyne or at Middlesbrough. With arrangements equal to these generally found at the works in the north-eastern district of England, this ought to represent about the additional cost of this description of pig iron upon the Rhine, supposing the sea freight to be the same to Rotterdam as it is to the Tyne or Tees. This difference of cost between the English and Rhenish works would not permit England to deliver iron at Ruhrort or Dortmund, because the expense of carriage from the Tyne or Tees on the pig, exceeds

* Mine iron is pig iron made without any admixture of cinder, some of which is used in the ordinary German metal for puddling.

that involved in the transport of the ore from Rotterdam to these places.

The ores besides foreign used in these German furnaces are:—

Luxemburg, which costs 8s. 6d. per ton for railway dues, the distance being 217 miles. The best only is used which yields 40 per cent. of iron.

Native ores, viz.:—

Bredelar, distance 75 miles away from the works, carriage 3s. 5d. per ton.
Nassau, „ 135 „ „ „ „ 5s. 3½d. „
Black Band obtained in the neighbouring coalfield.

I have roughly estimated that the railway dues on the materials for ordinary pig iron will be about 14s. per ton of metal, and on hematite iron, made from imported ore, about 10s.

Belgium, as has been already intimated, is now entirely dependent on imported ores for all branches of her iron trade. For puddling purposes and for basic iron the Luxemburg mines furnish the needful supply, the cost of bringing which varied in 1878 from 4s. 9d. to 5s. 6½d. per ton according to the situation of the furnaces, the distance to Liége being about 80, and to Charleroi about 100 miles. Pig iron was at that time brought from the Luxemburg furnaces, and sold at 42s. 11½d. to 43s. 2d. per ton, the carriage being a trifle above 6s. The extent of business would be small, because the carriage of coke to Luxemburg and iron back would be about 2¼ tons against nearly 3 tons of ore to be brought if smelted in Belgium, to which latter cost would have to be added the duty. At the time I heard of Belgian pig, made with a considerable admixture of cinder, being sold at 33s. 10d. per ton. The cost of transport on a ton of pig iron, allowing 1s. 6d. for the coke, will amount to 16s. 6d., from which an allowance must be made for the varying amount of mill and forge cinders, got on the spot and used in the blast furnace.

For Bessemer hematite pig, Belgium is entirely dependent on sea-borne ore, some African, but chiefly that of Bilbao. The

transport from Antwerp, a few years ago, was 2s. 4½d. by boat or 3s. 6¾d. by rail, so that the Belgium smelters are a little less favourably situated than the works in South Wales, as the sea freight to Cardiff is less than to Antwerp, and the carriage to the Welsh works from the port is also a little lower. The cost of extraction of Belgian coal is dearer than the Durham or Welsh, but, on the other hand, its yield of coke is about 80 per cent. against 65 per cent. in Durham, which will go far to equalise the cost of blast furnace fuel. Compared with furnaces on the Tyne or Tees, which receive their imported ore direct from the vessel, the transport on the materials may amount in England to 2s. 6d. and 3s., against 7s. 6d. to 8s. in Belgium, exclusive of the sea freight on the ore in both cases.

The United States occupy so different a position, relatively speaking, to European countries in connection with the manufacture of iron, that it will be most convenient to complete what I have to say respecting the latter before commencing with the American continent.

At page 57 *et seq.*, when describing the iron trade of the United Kingdom, the exports and imports of other countries were incidentally mentioned. It is now intended to supplement the remarks then made by some additional details in connection with those nations whose dealings in British iron have been distinguished by their importance.

GERMANY.—The chief competitor in our export trade is Germany, and it is proposed to give this country the first place in the present examination. The following table contains its transactions in iron for the last four years:—

TABLE XLV.

Year.	Pig Iron Made.	Pig Imported.	Pig Exported.	Pig Iron for Home Consumption, and Malleable Iron, Steel, &c., for Exportation.
1881	2,941,000	244,601	245,496	2,940,105
1882	3,170,957	283,009	186,938	3,267,028
1883	3,380,788	274,821	259,014	3,396,595
1884	3,572,155	264,501	230,008	3,606,648
Total tons	13,064,900	1,066,932	921,456	13,210,376

The imports and exports of iron and steel, inclusive of pig iron, during three of these years have been as follows:—

	Imports—Tons.	Exports—Tons.
1882	364,430	1,151,393
1883	327,065	1,143,171
1884	320,584	1,061,077

The quantity of pig iron made during these three years was 10,123,900 tons, against 675,960 pig and 2,679,681 iron and steel exported.*

If we adopt 25 cwt. of pig as having been consumed for each ton of the iron and steel, we have exports amounting to 4,025,561 tons of pig iron, or very close on 40 per cent. of the entire make of the empire.

In the report to the British Iron Trade Association (1884, p. 191) the make of Germany is given for the year 1870 at 1,391,000† tons. If these figures be correct the make has been increased above two and a half times in the last fourteen years, which, with the great increase in its exportations, might justify the supposition that, contrary to what has been advanced in these pages, Germany was able to enter the markets of the world on as favourable terms as ourselves.

This supposition is, however, expressly denied by the German manufacturers themselves, who have represented to the imperial

* These figures are taken from the British Iron Trade Association Reports for 1883 and 1884.

† Includes Luxemburg, omitted in Report.

government their inability to compete with the British manufacturers even when the iron or steel required by Germany lay at the very gates of their own forges and furnaces. In order to exclude competition, protective duties have been imposed on imported iron, at different dates, as follows:—

TABLE XLVI.

Year.	Pig Iron.	Make of Pig.	Bar Iron.	Ingot Steel.	Iron and Steel Rails.	Iron and Steel Plates.
	s. *d.*	Tons.	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*
1860	20 5	395,741	90 5	...	90 5	180 10
1865	15 3	771,903	50 9	...	50 9	71 0
1868	10 2	1,053,260	50 9	...	50 9	71 0
1870	5 0	1,391,000	35 6	...	35 6	50 9
1873	Free	2,240,000	20 3	...	20 3	30 3
1877	do.	1,932,000	Free	Free	Free	Free
1879	10 0	2,226,000	25 0	15 0	25 0	30 0

According to the data in my possession the Luxemburg ironmakers can lay down in the Rhenish works forge iron at a lower cost price than a similar pig can be brought from Middlesbrough, but as the latter has to pay a duty of 10s. per ton, no business, in periods of depression like the present, except at a loss, is practicable between the Tees and the ironworks on or near the Rhine. On the other hand, the German manufacturers cannot compete on equal terms with a Middlesbrough maker in malleable iron or steel rails, or indeed in iron in any of its forms or qualities for export, on account of their distance from a seaport. This observation is particularly applicable to the case of steel rails when the same were being sold at £4. 5s., free on board a vessel, as happened before the convention, already referred to in respect to this article, was established between the English and certain foreign manufacturers. Such a price as that just named would barely leave £4. at the works, and the manner in which the German makers are indemnified by carrying on an export business, upon which a loss may be incurred, is by making their own countrymen pay a much higher price for what they require for home consumption. The import duty on

steel rails, it will be seen from the table of rates just given, is 25s., which with 10s. per ton for freight and expenses from England, gives a Westphalian maker an advantage of 35s. over the English manufacturer. The usual difference charged for German wants is generally about 40s. above that obtained for what is exported.

If we assume, as I think we may, that the Rhenish and Westphalian works, to cover the extra cost of pig iron and the expense of shipment, are 15s. per ton worse situated than the English and Welsh works for carrying on a foreign trade, it may be deemed improbable that the German ironmasters extended their works, nearly 50 per cent. in five years, for the express purpose of competing with England in exporting their produce. Unfortunately the high prices their heavy import duties enabled them to demand from German consumers led them so to increase their make that its retention at home would have been ruin to the market. To avoid this, and to keep their works employed, they prefer losing money on their exports or a portion of them, which is repaid in the manner described by the railways and other customers in their own country.

At the time of its first introduction, the whole of Rhenish-Prussia, including Westphalia and Alsace-Lorraine, profited largely by the invention of the basic process. For the manufacture of steel rails large quantities of English hematite pig iron were formerly imported, and freights were so high that pig iron suitable for the Bessemer process was costly to manufacture from imported ore, even in the best placed furnaces near the Rhine. The Luxemburg and other phosphoric ores, together with the forge cinders, enabled the Rhineland manufacturers at that time to produce a basic pig iron for something like 20s. per ton less than that smelted from hematite. The expense of bringing Spanish ore from Bilbao is now so low that at Dortmund or Ruhrort pig iron can be made from it at so moderate a price that it would seem a matter of indifference whether rails are made by the basic or the acid process. This, however, is not

the case near Metz or in the Saarbrück district. In either of these localities hematite ore is dear, and the phosphoric ores are so cheap that metal suitable for the basic process can in certain places be made on as favourable or even more favourable terms than it, or any other kind of pig iron, can be produced on the river Tees. From the works so situated the carriage to a port is much higher than from the Rhine, viz., 12s., instead of 4s. or 5s. Notwithstanding this barrier to an export trade large quantities of iron have been sent, probably at a loss, to London and to India.

By the great extension of the iron trade in the German empire we have undoubtedly lost much valuable custom for iron which was consumed within its confines. By the production of this at home the German people infringed no economic law, for their own manufacturers could supply, unless prevented by expensive transport, the wants of their own country as cheaply, or more cheaply, than they could have been obtained from Great Britain. This, however, as we have seen, does not complete their interference with our trade, for Germany, as has been shown, is now sending out annually more than a million tons of iron (one-third of its make), which meets us in different markets of the world.

Under any circumstances iron so dealt with must be sold at a very much lower price than that which is taken for domestic use, owing to the latter having a clear benefit of the duty and freight, whereas the shipping orders enjoy no such advantage, but, on the contrary, have to bear the expense of being sent to a seaport.

It is difficult to see how in the long run Germany can fail to be seriously inconvenienced at times by having to cultivate so large an export trade as that in which it is now engaged. The manufacturers may, for a period, arrange among themselves to divide the foreign orders in such a way as to prevent the excess make they represent from interfering with their obtaining the higher price which the home market is made to pay.

Ultimately, one would suppose, competition will arise, not only in securing home orders, but in avoiding those for exportation, so that one scarcely sees how the foreign trade can fail to exercise a disastrous influence on the home market.

BELGIUM.—Belgium, considering the extent of its trade, is the largest exporter—not excepting Great Britain—among iron-making nations. Its annual make of pig iron may be taken at 750,000 tons, of malleable iron about 500,000 tons, and of steel 150,000 tons. To produce these latter, something like 913,000 tons of pig iron will be required, the deficiency being made up by a yearly importation of 130,000 to 180,000 tons.* Its exports may be regarded as equal to 12,000 tons of pig, 340,000 tons of malleable iron, and 90,000 tons of steel, the whole being equal to 585,000 tons of pig iron, or nearly 78 per cent. of its entire make. It is also worthy of note that the products sent abroad are disposed of in the very markets to which Great Britain has even a readier access than the Belgian makers possess.

The geographical position of the Belgian works enables sea-borne ore to be imported on more favourable terms than it can be procured for the Rhenish and Westphalian works, the average carriage from Antwerp to the former being about 3s. The cost of conveying Luxemburg ore to Liége or Charleroi is 6s. to 7s. per ton. We thus have a nation importing the whole of its ore, smelting it with coal dearer than that of every country except France, and carrying on a large export trade, with its home demand less protected by import duties than Germany or France.

The following table contains information respecting import duties per ton:—

* Some account should be taken of old rails and other forms of old iron and steel, and old metal returned to the manufacturers.

TABLE XLVII.

Year.	Pig Iron.	Bar Iron.	Ingot Steel.	Iron Rails.	Steel Rails.	Iron Plates.	Steel Plates.
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
1860	19 7	39 2	...	39 2	...	39 2	...
1865	4 2	16 0	...	16 0	...	16 0	...
1866	4 2	8 0	4 2	8 0	8 0	8 0	8 0

Make of pig iron in 1860 in Belgium, 319,943 tons; in 1883, 783,433 tons.

FRANCE.—Until recently the chief seats of the iron trade in France were situated on the coalfields such as St. Etienne, Bessèges, Commentry, &c. To the furnaces so placed ore was brought from greater or shorter distances, which generally was costly, from long carriage or from the nature of the deposits, or from both of these circumstances. The coal in this country is, generally speaking, expensive to mine, and is, looking at the area of the country, not plentiful, the total output being, at the present day, about 22 million tons. The extension of the manufacture of steel has compelled France, as it has done Great Britain, Germany, and Belgium, to make large importations of foreign ore, which amounted in 1883 to 1,597,206 tons. The make in that year of pig iron was 2,069,387 tons, and assuming the imported ore, some of which is rich, to have yielded 862,490 tons of iron, we have 1,206,897 tons due to native mineral, and such cinder from the mills as was sent to the blast furnaces. The French mines contribute about 3 to 3½ million tons of ore annually, so that without charging the furnaces with the mill and forge cinders they may use, the yield is equal to about 37 per cent. of pig iron.

France, partly from the dearness of her coal and partly from the geographical position of her works, does not occupy an important position as an exporter of iron. Nevertheless, she does send abroad a larger weight than circumstances, in respect to the considerations just mentioned, might have seemed to render

practicable. Thus in 1882 the exports were 115,935 tons, and in 1883 they were 120,643 tons, equal to about 7 per cent. only of the make of pig iron. In order to promote an export trade which, for the reasons just given, might be impossible, foreign iron is permitted to be imported free of duty against a corresponding weight of machinery, &c., sent out of the country. The mechanical engineer is not bound to use the iron so imported in the manufactured produce he intends to export, nor as a rule does he do so. He receives a certificate of the weight of iron converted into machinery and sent out of the country, which allows him to import a similar quantity. This certificate he may dispose of, for it carries with it to its holder the same privilege as that enjoyed by himself.

The duties levied on iron and steel entering France are as follows:—

TABLE XLVIII.

Year.	Pig Iron.	Bar Iron.	Iron Rails.	Steel Rails.	Iron Plates.	Steel Plates.
	s. *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*
1860–1864	39 2	97 6	97 6	...	195 0	488 4
1864	32 0	80 0	80 0	...	60 10	91 8
1865–1881	16 0	48 9	48 9	73 4	60 10	91 8
1882	12 0	40 10	40 10	48 9	57 1	73 4

Make of pig iron in France, 797,932 tons in 1860, and in 1883 it was 2,069,387 tons.

RUSSIA.—In Russia a similar system of exclusion to that in force in Germany is pursued, but in a more direct way, for there, after leaving the iron and steel makers to get as much as they can from the *home* consumer, the Russian Government pays a bonus to the maker for what is taken for *private* account. According to a statement which appeared in the *Newcastle Chronicle* (23d December 1885), as extracted from the *Moscow Gazette*, between 1875 and July 1884, £899,000. had been thus contributed by the Russian people, through the State, for the

benefit of the ironmasters. This payment amounts to nearly 40s. per ton on all iron or steel not being used for Government purposes. One case is given of a steel rail maker at St. Petersburg having received, on a contract of 29,000 tons, a bonus of nearly £50,000. The rails were manufactured from English iron with English coal, so that the mere labour of conversion was the only item of Russian industry which enjoyed the benefit of the protection afforded by the bonus. It would not be difficult to prove that practically the whole of the wages for converting the pig into rails was more than covered by the bonus.

The condition of the Russian iron trade is such as to render it a puzzling matter to bring its conflicting interests within the artificial stimulus of a protective duty. There is now sitting at St. Petersburg a conference of ironmasters and others to deliberate on this matter, at which apparently all interested in the question are represented by delegates, except perhaps that section of Russian society which probably, whatever the decision the ironmasters may obtain at the hands of the meeting, is sure to suffer. It appears that 97 per cent. of all the iron made in Russia is smelted with charcoal. One representative pleads on behalf of his works that he employs 5000 men, and pays upwards of £100,000. a year in wages, or about 1s. 4d. per man per day. The conditions of obtaining charcoal are such that even with labour paid at this miserable price, and with the forests for nothing, it would be impossible to make cheap iron.

One acre of forest is only capable of producing annually about 5 cwts. of charcoal. Allowing a furnace of the Middlesbrough type, 27,500 tons a year, an estate of 110,000 acres would be necessary to keep it at work, from all parts of which, along difficult roads, the charcoal would have to be carted.

A rail-mill situated in the distant Ural Mountains would, to enable it to deliver rails in the more populous parts of the empire, require such an amount of protective duty to place the owner in a position to compete against what he calls the "bastard establishments" of St. Petersburg, fed with English coal and English pig

iron, that he apparently dare not ask for it. He therefore suggests their disestablishment, but unfortunately for this proposal the Government thinks so differently that it pays, as we have seen, all the men's wages at the Petersburg work so as to keep it going. If, however, the advice of thirty-nine delegates—interested, it may be presumed, in Russian blast furnaces—is taken in preference to the twenty-one delegates who wisely want cheap pig iron, ultimately the importation of this article will be prohibited.

The following are the Russian duties, past and present, per ton:—

TABLE XLIX.

Years.	Pig Iron.	Bar Iron.	Ingot Steel.	Rails.		Plates.	
				Iron.	Steel.	Iron.	Steel.
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
1860 . .	10 10	75 10	163 4	75 10	Cannot be stated.	151 8	Cannot be stated.
1870 . .	10 0	68 9	158 4	39 2		98 4	
1876 . .	10 0	68 9	158 4	39 2		98 4	
1881 . .	10 0*	68 9*	68 9*	88 4*	88 4*	98 4*	98 4*
1882 . .	11 8	78 9	78 9	98 4	98 4	108 4	108 4
1884 . .	17 6	78 9	78 9	98 4	98 4	108 4	108 4
1885 . .	23 4	78 9	78 9	98 4	98 4	108 4	108 4
1886 . .	30 0	78 9	78 9	98 4	98 4	118 4	118 4

* With an addition of 10 per cent.

The following figures will show how comparatively small the interests are which Russia, as a nation, is called upon to protect, partly by actual bonus paid on what is made for the domestic use of the people, in addition, I suppose, to the heavy import duties:—

TABLE L.

Russia Coal and Iron.	1880.	1881.	1882.
PRODUCTION—	Tons.	Tons.	Tons.
Coal raised	3,214,895	3,437,726	3,742,380
Iron ore raised	995,055	1,001,055	...
Pig iron made	441,285	462,027	498,400
Finished iron made	288,512	321,678	291,800
Steel and steel rails	295,568	285,082	225,140
Steel rails included in above	198,188	203,303	not ascertained.
IMPORTS—			
Coal	1,838,816	1,730,417	,,
Pig iron	242,244	226,494	,,
Wrought iron	192,865	110,270	,,
Steel and steel rails	63,180	23,219	,,

SPAIN.—It has been alleged that Spain is rich in coal, 3000 to 3500 million tons being computed to exist in its known coal-fields. Such iron as is made within its confines does not depend on Spanish fossil coal for its production, for with the exception of Bilbao, where English coke is used, I believe all is smelted by means of charcoal. The country is rich in ores of iron, considerable quantities being shipped from the Mediterranean ports, but exceeding all others in abundance and in accessibility are the mines of Bilbao. From them there was obtained in the year 1882, 3,737,176 tons, of which 3,692,542 tons were shipped. In the three following years the quantities exported were as follows :—

TABLE LI.

To	1883.	1884.	1885.
	Tons.	Tons.	Tons.
Great Britain	2,312,210	1,981,864	2,050,519
Holland, for Germany	454,463	556,309	572,520
France	461,943	455,489	492,144
Belgium	141,918	150,047	171,771
Corsica	1,476	2,629	...
America	6,224	2,259	6,387
Total	3,378,234	3,148,597	3,293,341

In addition to the weights exported in the last three years there would probably be from 150,000 to 200,000 tons smelted in the furnaces built near the mines.

In no part of the world have I seen so large a mass of ore presented under more favourable circumstances for cheap extraction than the deposits from which 3 to 3¾ million tons are annually obtained at Bilbao. Upon the occasion of my visit in 1872 they were quarrying it from a cliff 180 feet in height with a further depth, it was said, of 40 to 50 feet lying below, so that the entire face would be 220 to 230 feet high, and so cheaply worked that at the present day it is put on board ships at a cost not exceeding four shillings per ton.

The large amount of shipping frequenting the port of Bilbao affords abundant facility of carrying coke and coal back at a very low freight. This has led to the erection of blast furnaces there, from which 30,000 tons of pig iron is about to be shipped for the United States. The freight to America is three shillings dearer than from Barrow, in spite of which the Bilbao firm obtained the order against the Lancashire houses.

Steel works and pipe foundries are either in course of erection or are contemplated, so that before long Bilbao may become a somewhat important iron-making locality. At the same time it may be noted that the best and cheapest-worked ores are being exhausted, and some persons do not speak very confidently of the long duration of the deposit generally.

Great Britain, it will be seen, is by far the largest customer for this ore, but according to a list of duties given in the Iron Trade Association Reports (1882, p. 93), we pay 35·73 per cent. more duty on iron entering Spain than other nations between which and that country more favourable treaties exist than with ourselves. English articles are charged per ton as follows:—

TABLE LII.

	Pig Iron.	Bar Iron.	Iron Rails.	Steel Rails.	Iron Plates.
	s. *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*	*s.* *d.*
1859	45 0	225 0	225 0	...	185 5
1860	17*s.* 1*d.* to 20*s.* 5*d.*	81*s.* 3*d.* to 97*s.* 6*d.*	81*s.* 3*d.* to 97*s.* 6*d.*	...	81*s.* 3*d.* to 147*s.* 6*d.*
1879	20 5	105 0	65 0	65 0	73 4
1882	20 5	105 0	65 0	65 0	73 4

UNITED STATES.—In many respects the iron trade of the United States presents some features of an anomalous character. We have, on the one hand, the comparatively modern blast furnace, with all its latest improvements, driven at a speed which leaves, perhaps with questionable economy, most other iron-making nations behind. On the other side, we have nearly 50,000 tons of malleable iron made a year in the prehistoric ore-hearth, often but little removed in construction from the apparatus used now only by semi-civilised people, and not differing in principle from what is still in use among barbarous nations.

Again, while in Europe we find countries abandoning their own forests as a source of fuel, and preferring to import coke from their neighbours, brought from distances of 200 miles or more, there is annually still made in the United States nearly three-quarters of a million tons of pig iron smelted with charcoal.

We have also in the United States such an unlimited area of land that the deficiencies of food in Europe, amounting to millions of tons a year, are supplied from their abundance. Notwithstanding a plethora of provisions and materials for clothing, both products of the soil, we have very commonly many of the necessaries of life dearer in America than in Great Britain. This and the having to recruit the labouring ranks by attracting immigrants, secured for the agricultural labourer fully thirty per cent. higher wages than the best paid farm servants receive in England. This form of labour, being the oldest and more important, in point of numbers employed, than all other branches of industry put together, may be regarded as a kind of starting-point for settling the rate of wages generally. This is the case in Europe, where usually we may assume that miners and iron-workers receive about twice the pay of the agricultural labourer in their immediate vicinity; but in America, where the agricultural earnings are thirty per cent. higher than in England, many of the men in the mines and ironworks average three or four times the wages of the farm servants in the great corn-growing states in the West.

Immense and rapid as has been the progress of the iron trade in Great Britain, that in the United States greatly exceeds it. Below is given, in thousands of tons, the make of pig iron in the two countries for several years, beginning at 1855, to which the American make of iron and steel, as far as I have been able to get them, has been added :—

TABLE LIII. (1 = 1000.)

Year.	Great Britain.	United States.		
	Pig Iron.	Pig Iron.	Malleable Iron.	Steel of all Kinds.
	Tons.	Tons.	Tons.	Tons.
1855	3,218	700	...	...
1860	3,889	821	...	...
1865	4,819	832	...	...
1867	4,761	1,305	930	...
1870	5,963	1,665	1,152	55
1875	6,365	2,024	1,428	389
1880	7,749	3,835	2,083	1,157
1881	8,144	4,144	2,360	1,588
1882	8,586	4,623	2,226	1,737
1883	8,529	4,595	2,097	1,673
1884	7,811	4,098	...	...

Thus it will be seen that while Great Britain increased its production of pig iron, between 1855 and 1882, 2·64 times, that of the United States was augmented 6·6 times.

This rapid increase in the make of iron in the United States indicates, in the absence of an export trade worthy of the name, the probability of the home demand for iron of various kinds exceeding often the powers of supply. This deficiency has been met by importations, occasionally very large, from foreign countries. The following shows the extent of these over a series of years (1 = 1000):—

TABLE LIV.

Description.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.
Pig iron .	219	264	138	54	60	74	60	66	303	700	465	539	322	184
Bar iron .	109	79	55	24	21	24	27	29	43	113	41	70	41	1
Hoop iron, &c.	11	10	7	1	...	...	...	...	1	21	1	...	1	...
Sheet iron .	10	9	10	6	3	1	1	1	4	10	7	11	8	...
Scrap iron .	196	248	97	36	23	12	10	5	221	619	135	147	64	34
Rails—iron .	460	340	88	7	2	...	...	...	17	118	119	37	1	...
Rails—steel .	45	133	143	90	14	...	...	...	22	143	220	162	34	275
Tin plates .	83	85	97	79	91	90	113	108	155	158	183	213	221	216
Totals * .	1133	1168	635	297	214	201	211	209	766	1882	1171	1179	692	710

Of these quantities the United Kingdom supplied the amounts stated in Table XXX., p. 64. The weights of steel ingots imported into the United States are not given in the returns, the values only being stated. The following table shows the supposed quantities represented by such values:—

TABLE LV.

Year.	Estimated Quantities of Steel Ingots Imported.	Year.	Estimated Quantities of Steel Ingots Imported.
	Tons.		Tons.
1871	48,572	1878	21,429
1872	50,692	1879	50,180
1873	36,294	1880	115,121
1874	29,598	1881	216,302
1875	28,043	1882	288,672
1876	23,213	1883	18,500
1877	22,724		

Making good the deficiency of iron in the United States by having recourse to importation from other countries has never been viewed with favour by certain American citizens. On the contrary, every effort has been used by them to resist what they consider an injury to American interests.

This has been the view invariably acted upon by the governing power, if I mistake not, since the earliest period of its separation from this country, and the usual method of an import duty was adopted for abating the alleged evil.

If it could have been shown to be indispensable for American

* The imports are sometimes given for the Fiscal year, which does not end 31st December.

interests that iron should have been manufactured in America under conditions however unfavourable, one would not be surprised that some extraordinary effort should have been exerted in its favour. This apparently was the opinion in 1824, when the import duties were raised, which allowed the bar iron makers at Pittsburg to pay a higher price than formerly for the pig metal they required for their works. This, at a considerable expense, was brought from a distance of about 120 miles in the Juniata Valley. The metal was carried over the Alleghany mountains in sledges during the winter to Johnstown. There it waited for the spring floods in the Conemaugh, Kiskiminetas, and Alleghany rivers to be conveyed in boats to Pittsburg. It seems, therefore, probable that three months would be occupied in carrying the metal over the snow and the next three months in sending it down the rivers, all intercourse between the two places for want of frosts and floods being suspended for the remainder of the year.

A trade so carried on was profitable to sledge-drivers, boatmen, forest owners, and charcoal burners, for although the superior economy of smelting iron by means of pit coal had been demonstrated for more than half a century in England, as late as the year 1838, almost every ton of pig iron produced in the United States was made with charcoal. This reluctance to change was not owing to the want of coal, for at that time there was annually worked in the United States 2 million tons of bituminous and 1 million tons of anthracite.

We have seen how, during the last century and the beginning of the present, the English iron trade experienced as severe trials as any which beset the American during the same period of time. A great believer in protectionist doctrine, the late Mr. Carey, pointed out that between the years 1835 and 1842 the American iron trade had remained stationary, and required, according to his views, additional protection, although in 1842, 18,694 tons, and in 1846, 24,187 tons was the weight of all the pig iron which was imported. The same want of progress com-

plained of by Mr. Carey has, in certain years, befallen the British iron trade, which was, and is, entirely unprotected by any import duty whatever. It is still suffering, but so also is the American, which cannot complain of insufficient protection, as may be perceived from the following list of import duties:—

TABLE LVI.

	1860.	1870.	1871.	1876.	1879.	1884.
		s. d.	s. d.	s. d.	s. d.	s. d.
Pig iron	24%	37 2	29 2	25 0	29 2	28 0
Bar iron	24%	92 1	92 1	93 4	93 4	74 8
Ingot steel . . .	12%	210 0	210 0	210 0	210 0	45%
Rails, iron . . .	24%	64 2	65 0	65 0	65 0	65 0
,, steel . . .	12%	45%	116 8	116 8	116 8	70 10
Plates, iron . . .	24%	115 0	140 0	140 0	140 0	116 8
,, steel . . .	12%	do.	210 0	210 0	210 0	45%

N.B.—Where the duty is given at so much per cent., it is *ad valorem*.

Underneath are given certain particulars, including values in England and America, which may be interesting when viewed in combination with the changes of import duties just given. They contain the progress of the American iron trade as well as the extent of the importations. By comparing the two we may form some idea whether the extension of works in the United States or the amount of the imports is most to blame for the low prices now prevailing there. Below the quantities the quotations of iron in Great Britain are also given.

TABLE LVII.

Statistics of the Make of Pig Iron, Stocks, &c., in the United States, compared with its imports (1 = 1000).

Year.	U.S. Make.	Stock of Pig Iron.	Mal. Iron Made.	Steel Made.	Imports.			
					Pig.	Scrap.	Steel.	Iron.
	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.	Tons.
1874	2,401	710	1,513	216	54	36	120	117
1875	2,024	679	1,428	389	60	23	42	117
1876	1,869	613	1,348	533	74	12	23	115
1877	2,066	573	1,318	569	60	10	23	141
1878	2,301	513	1,389	743	66	5	21	138
1879	2,742	127	1,827	935	303	221	72	220
1880	3,835	407	2,082	1,247	700	619	258	420
1881	4,144	198	2,360	1,588	465	135	436	351
1882	4,623	384	2,227	1,763	539	147	451	331
1883	4,595	477	2,098	1,675	322	64	52	272
1884	4,098	528	1,748	1,551	184	34	275	211

TABLE LVIII.

Quotations of Values of Different Articles.

Years.	English.				American.				Price of Anthracite Coal, Philadelphia.	Price of Gold.
	Cleveland Pig.	Wrought Iron.	Iron Rails.	Steel Rails.	Anthracite Pig.	Iron Rails.	Steel Rails.	Rolled Iron.		
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	Dollars.	Dollars.	Dollars.	Dollars.	Dollars.	
1874	3 10 11	10 9 5	9 18 2	12 1 1	30¼	58¾	94¼	67·95	4·55	112
1875	2 14 6	8 0 11	7 8 8	10 3 10	25⅛	47¾	68¾	60·85	4·39	114
1876	2 7 10	7 0 7	6 13 6	8 11 6	22¼	41¼	59¼	52·08	3·87	110
1877	2 2 1	6 15 3	6 11 11	7 2 4	18⅞	35¼	45⅛	45·55	2·59	105
1878	1 19 1	6 2 7	5 17 0	6 15 4	17⅛	33¾	42¼	44·24	3·22	102
1879	1 17 4	5 7 9	5 11 7	4 16 0	21½	41¼	48¼	51·85	2·70	100
1880	2 5 0	6 6 9	4 13 9	6 3 6	28⅛	49¼	67½	60·38	4·53	100
1881	1 19 2	6 0 9	5 0 9	5 16 8	25⅛	47⅛	61⅛	58·05	4·53	100
1882	2 3 5	6 10 7	5 0 0	5 15 0	25¾	45½	48½	61·41	4·61	100
1883	1 19 5	6 2 8	5 0 0	5 7 5	22⅜	...	37¾	50·30	4·54	100

The experience of many years past goes to prove that with high prices of iron the cost of production rises enormously. It has been shown in these pages how sudden the increase of demand not infrequently is. Good iron-workers are not taught in a day, and when their services are in great request it is not to be wondered at that they should seek for higher wages. In 1876, Mr. W. E. S. Baker, of Philadelphia, the secretary to the Eastern Ironmasters' Association, drew up the costs of pig iron from 1850 to 1876, which illustrates the truth of what has just been advanced. The following figures are extracted from what he says on the subject:—

TABLE LIX.

	1851.	1852.	1853.	1854.	1856.	1858.	1860.	1862.	1864.	1866.	1868.	1870.	1872.	1873.	1874.	1876.
	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.	Dols.
Ore . .	5·44	5·55	5·97	6·65	7·50	7·66	7·45	7·08	9·12	12·19	10·92	12·96	13·64	14·87	12·94	9·54
Coal . .	3·36	3·65	3·23	3·53	3·90	4·06	3·49	3·68	5·41	7·55	7·11	7·08	7·28	7·45	7·94	6·79
Limestone	·96	1·09	1·06	1·38	1·16	1·18	1·21	1·11	1·93	2·65	2·51	2·44	2·04	1·98	1·84	1·01
Labour .	1·61	2·02	2·00	2·45	2·58	2·10	1·87	1·57	2·85	3·46	3·86	3·89	4·69	5·11	3.65	2·54
Sundries	1·93	2·03	2·62	1·99	2·91	2·73	2·83	2·67	1·66	2·03	1·90	3·67	2·93	3·00	2·26	1·73
	13·30	14·34	14·88	16·00	18·05	17·73	16·85	16·11	20·97	27·88	26·30	30·04	30·58	32·41	28·6	21·61
Selling price .	21·⅜	22⅜	36½	36⅞	27⅛	22¼	22⅜	23⅞	59¼	46⅞	39¼	34¼	48⅞	42¾	30¼	22¼
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
Cleveland	...	...	...	...	...	...	...	...	55 0	53 3	43 2	50 3	97 1	109 2	70 11	47 10
Scotch .	40 1	45 5	61 5	79 9	71 0	54 5	53 6	52 6	57 6	60 0	52 9	54 4	101 10	117 3	8; 6	58 6

The following figures were copied by myself from the books of another firm who kindly placed the same at my disposal. They were those of furnaces situated in one of the ore regions, where, in consequence, coal was dear and ore cheap:—

TABLE LX.

	1860.	1871.	1874.
	Dols.	Dols.	Dols.
Cost of ore per ton of metal . .	2·95	6·84	9·78
,, coal ,, ,, . .	6·46	8·72	11·07
,, limestone ,, . .	0·10	0·29	0·36
,, wages ,, . .	1·72	2·60	2·75
,, Repairs, general charges, &c.	1·47	2·27	1·86
Total	12·70	20·72	25·22

The figures which follow show what Mr. Baker says in regard to the increased cost of bar iron in years of high prices:—

Table LXI.

	1851.	1852.	1853.	1854.	1856.	1858.	1860.	1862.	1864.	1865.	1866.	1868.	1870.	1872.	1873.	1874.	1876.
Pig used . Dols.	24·90	25·71	25·25	42·17	32·84	30·61	25·61	24·36	41·40	68·60	50·77	44·53	43·63	49·11	43·24	31·69	25·19
Coal . . . ,,	5·61	5·61	5·81	6·00	6·59	5·49	5·27	6·19	8·44	13·03	10·92	8·64	8·55	8·43	8·55	6·98	6·85
Labour . . . ,,	10·17	10·37	11·06	15·12	12·85	11·77	10·90	11·78	18·94	27·45	20·61	19·87	18·57	21·55	20·37	14·37	15·74
Sundries . . ,,	4·83	4·88	7·05	10·39	8·88	10·84	8·78	10 03	9·15	8·03	9·50	7·70	7·03	5·74	5·83	6·15	4·73
Total. . ,,	45·51	46·57	49·17	73·68	61·16	58·71	50·56	52·36	77·93	117·11	91·80	80·74	77·78	84·83	77·99	59·19	52·51
Dols.																	
Selling price of best refined rolled bar in Philadelphia .	54·66	58·79	83·50	91·33	73·75	62·29	58·75	70·42	146·47	106·38	98·13	85·63	78·96	97·63	86·43	67·95	52·08
									s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Middlesbrough . .	...	...	...	...	...	...	...	...	158 10	153 2	147 2	127 3	138 7	180 4	229 0	209 5	140 7

Now the lesson to be learnt from these figures is, not only that as iron rose in value the cost also rose, but that when it declined in price it was found impossible to reduce the cost in a corresponding degree. I have not had an opportunity of obtaining the particulars of the expense of manufacturing during later years, and am, therefore, unable to speak as to the relation costs now bear to the selling prices.

During the civil war all payments were made in Government paper money (greenbacks), which fell in value until in 1864 gold rose to 202. It would be difficult to say to what extent this affected the price of labour, or how much any change in wages was due to this or to extra demand or lessened supply of labour, owing to men being ordered under arms. The actual figures in Mr. Baker's tables have been retained, which I believe were made in order to exhibit how costs had been influenced by prices; indeed, the tables themselves show this fact independently of all change in the value of gold, as is evidenced by years in which paper money was at par (100).*

		1851.	1860.
Cost of pig . . .	dols.	13·30	16·85
Selling price . . .	„	21⅜	22¾

The experience of the American ironmasters finds a counterpart in that of the British. To show this, the largest iron-making district in the world has been selected—the north-eastern of England, which includes Cleveland—and the history of its development is set forth in the following figures, taken chiefly from the Government returns:—

* The present value of the dollar may be taken at 4s. In 1874 the paper dollar was only worth 3s. 9½d.

TABLE LXII.

	Cleveland Iron.		Price Scotch Pig to show difference.
	Make.	Average Price.	
	Tons.	s. d.	s. d.
1855	298,000	65 0	70 9
1860, average preceding five years	543,000	55 3	63 4
1865 " " "	811,000	52 3	55 6
1870 " " "	1,066,000	49 8	54 4
1871	1,813,000	49 8	58 11
1872	1,921,000	97 1	102 0
1873	2,000.000	109 2	117 8
1874	2,020,000	70 11	87 6
1875	2,049,000	54 6	65 9
1876	2,084,000	47 10	58 6
1877	2,109,000	42 1	54 4
1878	2,018,000	39 1	48 5
1879	1,767,000	37 4	50 4
1880	2,416,000	45 0	54 6
1881	2,634,000	39 2	49 1
1882	2,712,000	43 5	50 3
1883	2,780,000	39 5	46 9
1884	2,505,000	37 0	42 2

Now what I wish to show is that the average price of 52s. 3d. during the five years ending 1865 offered sufficient inducement to the iron manufacturers of the district to increase its average make by 268,000 tons per annum; and that in the succeeding five years an average price of 49s. 8d. brought about a further average annual increase of 255,000 tons. The production during this last quinquennial period rose gradually from 895,000 tons in the first to 1,627,000 tons in the last year. In 1871 a further increase of 186,000 tons in the make took place without any improvement in price, the average of the whole six years being 49/8 per ton.

The abnormally high rates iron of all kinds reached in 1872, 1873, and 1874, had the effect of raising the production of the North-Eastern district to about 2 million tons per annum. This was a quantity which practically was never exceeded during the next four years, and in the fifth, viz. 1879, there was an actual diminution of above 250,000 tons in the make.

It may here be observed that a mere comparison of the value of pig iron during the earlier years in the history of Cleveland, *with its subsequent* experience, does not afford a true measure

of the trade. This is due to the great improvement which was introduced in the construction of the furnaces, by which so great an economy was effected in the cost of production, that the lower prices of the four years ending 1879 as compared with those actually realised between 1860 and 1870, were about met by the saving which followed the change in the plant. Instead, however, of there being any increase in the make after the year 1874, corresponding with that of the decade ending in 1870, viz., above one million tons, the quantity of pig iron produced remained stationary.

The cause of this interruption to the progress of the district was due to the unprofitable nature of the trade during the four years ending in 1879, in which the reduction in the price of labour which prevailed in the years 1872, 1873, and 1874, bore no relation to the diminished value of the article it produced.

The year 1880, and the three following years, are distinguished by a remarkable addition to the output of the district we are considering, which went on increasing until it was more than 32 per cent. above the largest make ever turned out. This apparent improvement cannot, however, be ascribed to any expansion of the Cleveland iron-trade proper, for, according to the table given at page 18, the average annual weight of Cleveland ironstone raised during the four years in question was 36,000 tons less than the output of 1876. The real cause of the increase must, therefore, have been due to the large quantity of hematite ore now smelted in the furnaces of this district, which has been favoured by the cheap rates at which the Bilbao mines have delivered it on the Tees and Tyne.

The figures which have been made use of indicate a decline in the quantity of pig iron produced in the North-Eastern district of 275,000 tons in 1884 as compared with 1883. There is some reason for thinking that 1885 may also present an unfavourable result as compared with 1884, in which case we shall find a still further diminution in the annual make since 1883.

With regard to the cost of labour at the blast furnaces several circumstances have to be taken into the account before coming to any conclusion on its comparative amount between two countries. The general arrangements of the establishment itself may be inconsistent with the economical application of human agency. The nature of the work, owing to various causes, may differ; or for the same wages a different amount of duty may be performed.

Speaking generally, in the Northern States the situation of the smelting works in relation to the raw minerals do not permit the exercise of that economy which is to be found in such works as those near Middlesbrough. In the latter place train-loads of the raw materials arrive daily in such quantities as will serve for each day's consumption, and they are unloaded in such a way that they reach the furnace with the least possible expenditure of manual labour. Not infrequently considerable quantities of fuel require to be stocked at the American furnaces, and almost invariably this is the case in respect to the ore, which is brought from various places, and from such distances—500 miles or more—that it is impossible to work in the "hand to mouth style" which is practised in the English furnaces on the Tees. An inconvenient mode of disposing of the fuel, iron ore, and limestone may very easily involve an additional cost of 3d. on each ton, or even more, which of itself may mean 1s. per ton on the produce of the blast furnace.

My published opinions and private conversations with Mr. Porter, of the Census Office in the United States, on furnace labour have been questioned by the American press, and the *Iron Age* in May 1885 quoted the examples of several furnaces in proof of my mistaken views.

I have taken out the examples given in this paper where the *whole* number of men is given :—

	Men Employed.	Make of Iron per Week (tons).
Furnace A	75	625
„ E	75	700
„ H	61	630
„ J	64	605
„ K	58	573
	66·6	626·6 net tons, 2000 lbs. = 558 gross tons.

A Cleveland furnace generally runs from 475 to 500 tons per week, each ton of which involves the handling of about 5 tons of fuel, ore, and limestone against 3½ to 4 tons at the American furnaces. From these data it is estimated that the Englishmen may have to move 2400 tons, against 2100 tons to be dealt with by the Americans. Besides this, all the ironstone requires to be calcined in Cleveland, which is not the case in the United States at the furnaces in question. Notwithstanding this greater amount of work, I am within the mark in saying, that there are ten or fifteen fewer men at a Cleveland furnace than are engaged at the five American works just given.

After all, the main question is the cost of labour on the ton of the produce. By one correspondent I am told that I have made an improper selection of the American furnaces, and that had I taken those at a particular work he mentions the results would have been very different. I happen to have this information from several of the best smelting establishments in the United States, and the general result of my inquiries is, that the labour bills are notably higher than with us, partly from the cause just assigned, and partly from the fact that the rate of wages is higher than our own. Taking the entire staff, we will not be far from the mark in considering the total difference a few years ago to have been 20 to 33 per cent.—what it is to-day I have no data to show.

When we enter the malleable ironworks, the disparity in the men's earnings between the old and new world is more striking than it is at the blast furnaces. I will give them for two or three separate years:—

TABLE LXIII.

Prices paid for Puddling per ton.

Year.	Middlesbrough.	South Wales.	South Staffordshire.	Belgium.	Germany.	France.	United States.
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d. s. d.*
1874	10 10	6 6½	10 10	6 0½	...	23 6½	21 9 to 22 7½
1876	7 8½	5 0	8 10½	5 8½	...	16 0½	13 2 to 16 0
1879	7 0	3 10	7 0	4 6½	6 2	12 3	13 10

In 1879, while the head puddlers in the Middlesbrough Works were earning about 7s. per day, and their underhands 2s. 6d., similar workmen in the United States were being paid 11s. 4d. and 6s. 8d. respectively. Taking the entire staff of a puddling forge, I am within the mark in saying, that in 1879 the cost of labour was more than 50 per cent. higher on a ton of puddled bars than it was in England, and so far as my information enables me to judge the same observation may be applied to the finishing mills.

In recent years very great improvements have been made in the machinery, and arrangements generally, connected with the manufacture of steel rails. It would, therefore, not be fair to compare the American labour of 1879 with those of England in 1885, the latter being about one half the cost of the former. Each was from the best and, at the time, most modern examples, but probably since 1879 the American practice may have been improved, although I question its having been done sufficiently to bring it upon a level with the latest built English mills.

It has already been shown on page 60 that the United States have become the largest consumers of iron in the world, and that their importations have been most irregular in point of extent. That American citizens should view with any feelings but those of satisfaction the present extent of their own iron manufacture no one will question, but whether all the circumstances connected with its development present equal cause for congratulation, even to the manufacturers themselves, may be open to doubt.

Time has not allowed me to make a proper analysis of all the circumstances connected with the development of the iron trade in the United States and that of other countries. At present I will therefore content myself with tabulating its growth there and in other countries, and to this I have added the values of various articles in Great Britain and in the United States.

TABLE LXIV. (1 = 1000).

Year.	Pig Iron, U.S.A.	Imports, U.S.A., reduced to Pig Iron.	Pig Iron Make in					
			Great Britain.	Germany.	France.	Belgium.	Sweden.	Austro-Hungary.
	Tons.	Tons.	Tons.	Metric Tons.	Metric Tons.	Metric Tons.	Metric Tons.	Metric Tons.
1871	1,706	1,219	6,627	1,563	859	609	293	424
1872	2,548	1,238	6,741	1,988	1,217	655	334	459
1873	2,560	616	6,566	2,240	1,366	607	339	534
1874	2,401	255	5,991	1,906	1,423	532	332	494
1875	2,023	137	6,365	2,029	1,416	540	343	454
1876	1,868	121	6,555	1,846	1,453	490	344	400
1877	2,066	106	6,608	1,932	1,522	470	336	409
1878	2,301	111	6,381	2,147	1,508	493	333	...

The following quotations are of interest when taken in connection with the figures given above (Table LXIV.):—

TABLE LXV.

Price.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.
Gold . . .	115	112	112	113	112	114	110	105	102
Anthracite pig .	$33\frac{1}{4}$	$35\frac{1}{8}$	$48\frac{7}{8}$	$42\frac{3}{4}$	$30\frac{1}{4}$	$25\frac{1}{2}$	$22\frac{1}{4}$	$18\frac{7}{8}$	$17\frac{5}{8}$
American refined bars . .	78·96	78·54	97·63	86·43	67·95	60·85	52·08	45·55	44·24
American iron rails	$72\frac{1}{4}$	$70\frac{3}{8}$	$85\frac{1}{8}$	$76\frac{3}{4}$	$58\frac{3}{4}$	$47\frac{3}{8}$	$41\frac{1}{4}$	$35\frac{1}{4}$	$33\frac{3}{4}$
American steel rails	$106\frac{3}{4}$	$102\frac{1}{2}$	112	$120\frac{1}{2}$	$94\frac{1}{4}$	$68\frac{3}{8}$	$59\frac{1}{4}$	$45\frac{1}{2}$	$42\frac{1}{4}$
Anthracite coal .	4·39	4·46	3·74	4·27	4·55	4·39	3·87	2·59	3·22
Scotch pig at Glasgow . .	s. d. 54 4	s. d. 58 11	s. d. 102 0	s. d. 117 3	s. d. 87 6	s. d. 65 9	s. d. 58 6	s. d. 54 4	s. d. 48 5
Cleveland pig .	50 3	49 8	97 1	109 2	70 11	54 6	47 10	42 1	39 1
Freight on pig iron from United Kingdom .	s. d. 19 0	...	s. d. 16 0	s. d. 15 9	s. d. 6 5	s. d. 4 3	s. d. 1 9	s. d. 3 0	s. d. 2 6

The enormous trade in grain and provisions carried on between our own country and the United States requires the co-operation of a vast number of vessels. When the weight

to be carried one way greatly exceeds that going in the other, the rates of freight in the opposite directions fluctuate considerably. Thus, in the four years beginning 1870 there was a large quantity of iron and other commodities requiring shiproom to the United States, and in these years the cost of transport on pig was high, 15s. 9d. to 19s. per ton. During the next four years the imports into the United States from Great Britain fell off. This caused the freight on corn, &c., to rise, and that on pig iron to decline, the charge on the latter varying from 1s. 5d. to 4s.

The difficulties attending any attempt to make a complete analysis of the sources of consumption of iron have already been referred to. These are very great, even for the resident in the country to which the inquiry applies, and they are greatly increased when it is a foreign land which has to be examined. I have, however, recently obtained an instalment of information on the wear of rails in America through my friend Mr. Wm. P. Shinn of New York, a great authority on railway matters in the United States. He very courteously promises further details, but time will not permit me to defer making the best use I can of what he has already most promptly communicated.

Iron shipbuilding in the United States has not yet risen to a point of any importauce. In consequence, although the vessels launched have been chiefly steamers, the consumption of iron in this branch of industry has been insignificant. The following is the tonnage constructed according to the returns of the American Iron Trade Association:—

	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.
Tonnage . . .	8,281	15,479	12,766	26,528	33,097	21,632	21,346	5,927

	1878.	1879.	1880.	1881.	1882.	1883.	1884.
Tonnage . . .	26,960	22,008	25,582	28,356	40,097	39,646	35,632

In the following table is calculated, in the same manner as on page 44, the total consumption of pig iron for shipbuilding purposes :—

TABLE LXVI.

Years.	Iron and Steel in Hulls of Steamers.	Machinery.	Iron and Steel in Hulls of Sailing Ships.	Total.	Pig Iron required for both at 26 Cwt. per Ton.
	Tons.	Tons.	Tons.	Tons.	Tons.
1870	3,801	874	339	5,014	6,518
1871	6,706	1542	1033	9,281	12,065
1872	6,383	1468	nil	7,851	10,206
1873	13,274	3053	,,	16,327	21,224
1874	16,548	3896	,,	20,444	26,577
1875	10,816	2488	,,	13,304	17,295
1876	10,673	2455	,,	13,128	17,066
1877	2,964	682	,,	3,646	4,739
1878	13,480	3100	,,	16,580	21,554
1879	11,004	2531	,,	11,535	14,996
1880	12,769	2937	22	15,728	19,446
1881	14,160	3257	18	17,435	22,666
1882	20,048	4611	nil	24,659	32,056
1883	18,806	4325	1016	24,147	31,391
1884	15,600	3588	2216	21,404	27,825

Pipes for gas and water works doubtless form an important item, but of the exact amount I have, as indeed was the case for the United Kingdom, no returns. We must therefore assume, whatever the actual consumption was, that it was spread pretty uniformly over the entire period.

At the end of 1869 the mileage of railroad according to Poor's table, as given in the American Iron and Steel Association Report for 1883, was 46,844 miles. At the end of 1878 the length built was 81,776 miles, showing an increase during the nine years of 34,932 miles. They were constructed as follows :—

	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.
Miles .	6070	7379	5878	4107	2105	1713	2712	2281

	1878.	1879.	1880.	1881.	1882.	1883.	1884.
Miles .	2687	4721	6957	9788	11,596	6754	3950

The rails made and imported during these years were as follows (1=1000):—

TABLE LXVII.

	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.
Made . . .	554	693	893	795	651	708	785	683
Imported . .	356	505	474	231	96	16	nil	nil
Total tons .	910	1,198	1,367	1,026	747	724	785	683
		1878.	1879.	1880.	1881.	1882.	1883.	1884.
Made		788	994	1,305	1,647	1,508	1,215	1,021
Imported.		nil	39	259	346	200	35	28
Total tons . . .		788	1,033	1,564	1,993	1,708	1,250	1,049

According to Mr. Shinn, the following table contains the length of rails laid down in the United States:—

TABLE LXVIII.

Year.	Miles of Line.	Extra Track and Sidings.	Total Miles of Track.	Increase.	
				Line.	Track.
1870	52,898	10,579	63,477	...	...
1875	74,658	17,078	91,736	21,760	28,259
1880	93,669	21,977	115,646	19,011	23,910
1884	125,152	31,345	156,497	31,483	40,801

Of the total length in 1880, viz., 115,646 miles, 33,679 miles were of steel, say nearly 30 per cent. Since 1880 the steel laid down has increased to 90,242 miles, being nearly 60 per cent. of the whole.

The weight per yard of the rails used in the United States varies from 50 to 75 lbs. per yard. The average, Mr. Shinn thinks, may be taken at 60 lbs. per yard, which, with spikes,

&c., brings up the quantity to 100 tons of iron or steel per single mile. No chairs are employed, the rails being of the Vignoles type. We have therefore :—

TABLE LXIX.

Year.	Total Weight of Rails, &c., Laid Down.	Year.	Required for New Lines.
	Tons.	Between	Tons.
1870 . . .	6,347,700	...	...
1875 . . .	9,173,600	1870 and 1875	2,825,900
1880 . . .	11,564,600	1875 ,, 1880	2,391,000
1884 . . .	15,649,700	1880 ,, 1884	4,085,100

In respect to the durability of rails, Mr. Shinn states that on the lines of *heavy traffic* he does not consider that more than ten years can be counted on as being the life of steel, and he considers that ten years also represents the life of an iron rail on lines of *more moderate traffic*. It may be observed that this opinion of the duration of steel rails is founded on an opportunity of ascertaining the quality of those made at home, and of those obtained from Great Britain or elsewhere; for since 1871 the quantity of the latter was 408,000 tons, against 7,996,000 tons made in the United States.

It will be assumed in the following calculation that all the rails in existence in 1870 were renewed at the rate of one-tenth of the total weight per annum, and that of the quantity laid down between that year and 1875, 1,325,700 tons had also to be relaid at the same rate. This gives 7,673,400 tons to deal with, or an average of 767,340 tons a year requiring renewal. Regarding the whole quantity taken up to have been iron, and adopting the formula given at page 37, the pig iron required, in addition to remanufacturing the old rails, would be a trifle under 180,000 tons per annum.

By a very rough estimate, it is assumed that for every 100 tons of rails in use on the American lines, the rolling stock,

reckoning it to contain the same quantity of iron as that in use in the United Kingdom, will weigh 40 tons.*

I am without any information as to the quantity of iron consumed in stations, bridges, &c., in the United States, but the railways being single lines, I will take it as 15 tons per mile, instead of 35 tons as in the United Kingdom.

From these data, I infer that the following will show roughly, *in pig iron*, the annual requirements of the United States for railway purposes during the last seven years :—

TABLE LXX.

	1878.	1879.	1880.	1881.	1882.	1883.	1884.
Renewals of old rails	150,000	150,000	150,000	150,000	150,000	150,000	150,000
New lines laid down = 120 tons pig iron per mile	322,440	566,520	834,840	1,174,560	1,391,520	810,480	474,000
Renewals of rolling stock on same basis as that observed in United Kingdom . . .	192,000	192,000	192,000	192,000	192,000	192,000	192,000
New rolling stock built for new lines, taken at 50 tons pig iron per mile . . .	134,350	236,050	347,850	489,400	579,800	337,770	197,500
Total tons . .	798,790	1,144,570	1,524,690	2,005,960	2,313,320	1,490,250	1,013,500

It will thus be seen that the above figures show an increase in the United States of pig iron required, for railway purposes alone, of 1½ million tons between 1878 and 1882, and that the demand fell off to the extent of more than 1¼ million tons between 1882 and 1884.

These very great fluctuations in the quantities of iron used for railway purposes render it easy to understand that the extent

* Mr. Shinn gives the following as the numbers of the rolling stock on the lines of the United States :—

	1875.	1880.	1884.
Locomotives	15,564	17,949	24,587
Passenger carriages	13,055	17,575	23,904
Merchandise and mineral waggons	376,713	539,355	798,899

of the imports, as well as the home make, should be materially affected. Prices declined to a point which the manufacturers, weighted with increased costs of production, as exemplified in the table at page 131, found it difficult to meet. Coal owners, proprietors of ore mines, and workmen all conspired to keep up their charges, which it was impossible the furnace and forge owners could afford to pay. The complaint when I visited the States in 1874 and 1875 was universal, and Mr. Baker, whose tables I have quoted, attributes part of the increased cost to the "rapacity of the coal operators and the greed of the railroads." His language is not so clear when he speaks of labour being at starvation prices, seeing that he gives for 1851 the wages on pig iron at 1·61 dollars, and on bars at 10·17 dollars—both high rates—and after being 5·11 dollars and 21·55 respectively in 1865, they leave off in 1876 at 2·54 dollars on pig, and 15·74 dollars on bars. These rates (1876) were more than double what were paid in Europe.

At this point I would again draw attention to the changes in the cost of ore, coal, and limestone per ton of iron as given in Mr. Baker's tables:—

	1851. dols.	1873. dols.	1876. dols.
Ore	5·44	14·87	9·54
Coal	3·36	7·45	6·79
Limestone	0·96	1·98	1·01

Under such inflictions—"extortionate prices," as they were called in the statement in the *Iron Age* of New York—it is not surprising that 40 per cent. of the ironworks had failed since the year 1873.

The whole history of manufacturing industry in America presents, perhaps, no parallel to the extraordinary development which took place in the iron trade immediately after the year 1879. The nature of this comparative development may be judged of by a reference to the following table (1 = 1000):—

TABLE LXXI.

Year.	Pig Iron, U.S.A.	Total Imports, U.S.A. Reduced to Pig Iron.	Pig Iron Make in					
			United Kingdom.	Germany.	France.	Belgium.	Sweden.	Austro-Hungary.
	Tons.	Tons.	Tons, 2240 lbs.	Metric Tons.	Metric Tons.	Metric Tons.	Metric Tons.	Metric Tons.
1879	2,741	831	5,995	2,226	1,344	448	348	404
1880	3,835	2,027	7,749	2,729	1,733	610	405	455
1881	4,144	1,323	8,144	2,941	1,894	624	435	523
1882	4,623	1,314	8,586	3,170	2,033	726	398	606
1883	4,595	771	8,529	3,380	2,069	783	422	682
1884	4,098	490	7,811	3,572	...	...	...	...

The rapid increase of activity in the United States disclosed by the figures given in this table, so far as my information enables me to judge, raised the value of iron-making minerals to their old prices of 1873. It, moreover, produced an immediate effect on prices of iron, which was not felt, except very momentarily, in Europe. The following shows the nature of the change, the price of gold being practically at par during the whole period:—

TABLE LXXII.

Price of	1878.	1879.	1880.	1881.	1882.	1883.	1884.
Gold	102	100	100	100	100	100	100
American anthracite pig .	$17\frac{5}{8}$	$21\frac{1}{2}$	$28\frac{1}{8}$	$25\frac{1}{8}$	$25\frac{3}{4}$	$22\frac{3}{8}$	$19\frac{7}{8}$
American refined bars .	44·24	51·85	60·38	58·05	61·41	50·30	44·05
American iron rails . .	$33\frac{3}{4}$	$41\frac{1}{4}$	$49\frac{1}{4}$	$47\frac{1}{8}$	$45\frac{1}{2}$	...	...
American steel rails . .	$42\frac{1}{4}$	$48\frac{1}{4}$	$67\frac{1}{2}$	$61\frac{1}{8}$	$48\frac{1}{2}$	$37\frac{3}{4}$	$30\frac{3}{4}$
American anthracite coal .	3·22	2·70	4·53	4·53	4·61	4·54	4·42
	s. d.	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*	*s. d.*
Scotch pig iron at Glasgow	48 5	50 4	54 6	49 1	50 3	46 9	42 2
Cleveland pig, Middlesbro'	39 1	37 4	45 0	39 2	43 5	39 5	37 0
Freight on pig iron from Unit. King. to U.S.A.	2 6	4 6	10 0	7 0	...	...	...

Until the last year or two Great Britain, in reality, supplied all the world, with the exception of the United States, Germany, France, and Belgium, with rails. If, then, to our own consumption we add the quantity we have exported, we get an idea of the extent of the entire make of the United Kingdom.

In the exports from this country of rails, railway fastenings are included. I have therefore added the weight, in the table which follows, of the chairs generally used in Great Britain, so as to preserve uniformity (1 = 1000 tons) :—

TABLE LXXIII.

	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.
Exported * . .	583	888	1,059	981	945	785	782	546	414
Used at home .	108	179	65	65	155	112	108	90	122
Tons . .	691	1,067	1,124	1,046	1,100	897	890	636	536

	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.
Exported * . . .	498	439	463	693	820	937	971	728
Used at home. . .	68	109	157	93	60	114	46	106
Tons . . .	566	548	620	786	880	1,051	1,017	834

* Exports to United States are included.

This want of demand for rails continues seriously to affect the British iron trade. At my request, an application was made to eleven large rail-making firms by the Secretary of the British Iron Trade Association, to ascertain their rail-making capacity, and the extent to which the same had been employed during the past year. The following is the result of my inquiry :—

	Annual Capacity of Works. Tons.		Production in 1885. Tons.
A	130,000		48,889
B		No returns.	
C	230,000		57,290
D		No returns.	
E	30,000		19,166
F	170,000		70,761
G	120,000		26,846
H	208,000		76,876
I	72,800		25,584
J	104,000		24,369
K	52,000		nil
Total . .	1,116,800		349,781

It is obvious, from what is already known respecting the quantity of rails which has been produced in 1885, that the production given is very far short of the entire make of the kingdom.

The means of computing the make of rails in Germany, France, Belgium, Austro-Hungary, and Russia, which practically comprise all other countries, mentioned below, are not satisfactory. The quantities are not always given, and when they are, there is some doubt as to their correctness. The following are the nearest approximation I have been able to make as to their amount, and for the purposes of the present calculation they may perhaps be taken as sufficiently near the truth (1=1000 tons):—

TABLE LXXIV.

	1878.	1879.	1880.	1881.	1882.	1883.	1884.
Germany	250	336	408	530	524	474	400
France	280	290	300	303	380	410	387
Belgium	90	100	100	130	135	131	135
Austro-Hungary . . .	100	90	100	100	120	149	140
Russia	50	50	208	205	200	200	200
Total .	770	866	1,116	1,268	1,359	1,364	1,262

From what has preceded, the make of rails in the world during the seven years ending 1884 is taken to be (1=1000 tons):—

TABLE LXXV.

	1878.	1879.	1880.	1881.	1882.	1883.	1884.
Gt. Britain, including chairs, &c.	548	620	786	880	1.051	1,017	834
United States rails, gross tons .	788	994	1,304	1,646	1,508	1,214	1,021
Other countries. . . .	770	866	1,116	1,268	1,359	1,364	1,262
Total make of rails, &c., tons .	2,106	2,480	3,206	3,794	3,918	3,595	3,117
Taken as equivalent in pig iron, at 24 cwts. per ton . .	2,527	2,976	3,846	4,552	4,700	4,313	3,740
For other purposes, such as rolling stock, bridges, &c., &c., roughly estimated at one-third of the weight of iron used for the permanent way . .	842	992	1,282	1,517	1,566	1,437	1,246
Total tons .	3,369	3,968	5,128	6,069	6,266	5,750	4,986

From these figures should be deducted the weight of worn-out rails taken up for remanufacture. This, for the seven years in question, would be a pretty constant quantity, because practically no renewals would take place of either iron or steel on lines laid down since 1873. At the present time the total length of railways in the world does not, probably, exceed 250,000 miles. In 1869 it was probably under 100,000 miles, so that the quantity of old rails taken up is by no means commensurate with the actual quantity now manufactured.

Neglecting the old rails so returned, the following figures show, but only approximately, what ratio the pig iron used for all railway construction bears to the world's production of pig iron (1=1000 tons):—

TABLE LXXVI.

	1878.	1879.	1880.	1881.	1882.	1883.	1884.
Make of pig iron	14,091	14,048	18,077	19,277	20,726	21,063	20,281
Used for railways	3,369	3,968	5,128	6,069	6,266	5,750	4,986
Percentage of the world's make used for railways	24	28	28	31	30	27	24
Pig iron left for other purposes after supplying that required for railways .	10,722	10,080	12,949	13,208	14,460	15,313	15,295

We have, unfortunately, no complete record of the stocks of pig iron on hand. Those for the United Kingdom and the United States (in makers' hand and public stores) were as follows (1=1000 tons):—

1878.	1879.	1880.	1881.	1882.	1883.	1884.
1,874	1,539	1,997	1,946	2,087	2,202	2,402

showing an increase, as between 1878 and 1884, of 528,000 tons. Of this increase 509,000 tons belong to the United Kingdom. Probably, therefore, we shall not be far wrong in supposing that the increase in the iron-making countries did not at the end of 1884 exceed that at the end of 1878 by above 600,000 tons. I

we take the averages of 1878 and 1879, and deduct 600,000 tons from the averages of 1883 and 1884, we have the following figures:—

Average for 1883 and 1884 of pig iron left for other purposes than for railways	15,304,000
Deduct increase of stocks since 1882	400,000
Average consumed 1883 and 1884 for other than railway purposes	14,904,000
Average for 1878 and 1879 of pig iron consumed for other purposes than railways	10,401,000
Increased consumption after providing for that required for railways	4,503,000

The following items show the increases in the seven years ending 1884 (1=1000 tons):—

TABLE LXXVII.

	1878.	1879.	1880.	1881.	1882.	1883.	1884.
Shipbuilding, U. K., *vide* Table XVII., p. 46. .	401	384	390	579	763	860	611
Shipbuilding in U. S. A., *vide* p. 130 . . .	21	14	19	22	32	31	27
Tin plates, as per Government returns . .	198	190	237	280	238	315	349
Wire and wire rods—no data, but considerable increase . . .	...	...	...	...	...	...	...
Water and gas pipes—Mr. Cochrane's estimate of make in U. K.	500	500	500	500	500	500	500
Do. in other countries, taken at one half of U. K.	250	250	250	250	250	250	250
Sundry other uses . .	9,352	8,742	11,553	11,577	12,777	13,347	13,567
Total, exclusive of railway purposes (tons) .	10,722	10,080	12,949	13,208	14,460	15,313	15,295

If the surmise be correct that the more important sources of consumption, such as railways and other items just enumerated, do not afford an explanation for the enormous increase which has taken place in the quantity of iron which has been employed, we are constrained to infer that a general growth has taken place in the numerous smaller uses to which the metal is applied. Even with this supposition we cannot fail to see the difficulty in accounting for so rapid a rise as that which marked the period between 1878 and 1884, viz., 4,303,000 tons,

unless indeed the railways, shipbuilding, &c., absorbed a greater weight of iron than that set against them, which does not seem probable.

I would here quote a table given in Mr. Jeans' Report to the British Iron Trade Association in 1882. It exhibits the consumption of iron per head of population in the world:—

TABLE LXXVIII.

Country.	Population.	Tons Consumed.	Lbs. per head consumed.
United Kingdom	35,968,000	4,618,932	287·53
United States of America	50,152,866	6,065,919	270·92
France	37,672,048	2,508,706	149·16
Germany	45,194,177	2,488,957	123·36
Belgium	5,519,844	587,000	238·20
Russia	88,000,000	965,000	24·66
Austrian Territories	37,741,434	625,000	37·09
Sweden and Norway	6,391,098	220,000	77·07
Other countries of Europe	91,694,283	978,449	23·90
Total for Europe and United States	398,333,750	19,057,963	107·16
British possessions, exclusive of India	11,465,079	621,483	121·40
Do. in India	446,759,606	481,951	2·40
Egypt	5,517,000	18,614	7·55
South America and Islands	45,449,357	274,353	13·50
Asia, exclusive of British possessions	517,161,778	113,382	·49
Total	1,424,686,570	20,567,746	32·33

According to these figures the first five countries, containing 174,506,935 inhabitants, consumed 16,269,514 tons of iron, equal to 208·84 lbs. per head per annum. The remaining European nations, including probably Asiatic Russia, and numbering 223,826,815 inhabitants, only used 2,789,440 tons, or 27·80 lbs. per head per annum. Now if these last, comprising many nations of the most advanced civilisation, added 50 lbs. to their annual demand of iron, 4,999,130 tons would be needed for this purpose alone. With this increase to their present requirements, their consumption would only be 37 per cent. of that taken by the first five nations.

Leaving "British possessions," exclusive of those in India, as it is, viz., 121·40 lbs. per head per annum, and without any addition to the 27·80 lbs. consumed by certain European nations, and dealing with the remainder of the globe, viz., 1,014,887,741 inhabitants, who only receive 888,300 tons, or 1·96 lbs. per head per annum, an increase of 10 lbs. to their consumption would give an annual total of 4,530,740 tons.

Now, as a matter of fact, we know that countries which formerly received little or no iron are now becoming considerable consumers, and others which took moderate quantities have largely increased their demands. The figures themselves will only afford a partial explanation of the great increase in the consumption observed since the year 1879, because in some cases a considerable portion of our exports to these countries consisted of rails which, having already been accounted for, are not included in the sundry uses. It may, however, be interesting to show the character of the increased demand in some cases, as stated in the Report of the British Iron Trade Association for 1884.

Exports from the United Kingdom.

	1878.	1883.
Portugal	32,079	44,590
Spain	72,111	86,499
Philippine and Ladrone Islands	4,444	6,913
Spanish West Indian Islands	14,130	19,579
Italy	79,129	225,227
Austrian Territories	7,423	14,801
Greece	5,918	9,054
Roumania	12,666	45,747
Turkey in Europe	10,360	18,184
,, Asia	6,804	13,262
Egypt	12,322	16,354
West Coast of Africa	3,621	4,618
China	26,604	35,490
Japan	18,046	21,540
Pacific Islands, excluding Fiji	1,709	3,003
Hayti and St. Domingo	823	1,302
Mexico	9,355	43,432
Central America	1,753	8,782
New Granada	1,386	4,896

	1878.	1883.
Bolivia	190	1,758
Chili	12,720	30,834
Brazil	65,012	72,012
Argentine Republic	21,884	204,129
Malta and Gozo	1,972	2,972
Cape of Good Hope	24,100	55,290
Natal	6,923	16,516
British India, exclusive of Straits Settlements and Ceylon	207,274	360,400
Bombay and Scinde	116,966	152,312
Madras	14,690	26,467
Bengal and Burmah	75,618	181,621
Straits Settlements	5,552	8,782
Hong-Kong	7,237	9,838
West Australia	2,296	3,464
Victoria	50,919	52,465
New South Wales	56,876	109,053
Do.	56,903	96,524
Queensland	15,909	61,688
Tasmania	2,200	9,784
Fiji Islands	...	1,530
British North America (Canada)	104,378	232,151
Newfoundland	2,146	4,244
British West Indies	7,680	13,862

In order to ascertain the increment of iron and steel exported from the United Kingdom besides railroad iron, the figures given below have been extracted from the statistical abstracts issued by the Government. The weight of machinery exported is given in these accounts as value, and the weight has been assumed by taking the whole at £30 per ton. This is not quite a satisfactory mode of arriving at the weights, because, as formerly mentioned, we have no means of forming any opinion as to the character of the machines, which, moreover, vary considerably in value with the price of iron:—

TABLE LXXIX. (1 = 1000 Tons.)

	1870.	1871	1872.	1873.	1874.	1875.	1876.	1877.	1878.	1879.	1880.	18 1.	1882.	1883.	1884.
Railroad iron, all sorts	1,059	981	945	785	782	546	414	498	439	463	693	820	937	971	729
Machinery	176	199	273	334	326	302	240	224	249	242	309	332	398	447	435
Iron of various kinds	1,766	2,188	2,438	2,173	1,705	1,911	1,809	1,848	1,858	2,419	3,100	3,000	3,416	3,072	2,768
	3,001	3,368	3,656	3,292	2,813	2,759	2,464	2.570	2,546	3,125	4,102	4,152	4,751	4,490	3,932
Percentage of each—															
Railroad iron, all sorts . . .	35·2	29·1	25·8	23·8	27·7	19·8	16·8	19·3	17·2	14·8	16·9	19·7	19·7	21·6	18 5
Machinery	6·0	5·9	7·5	10·2	11·6	11·0	9·8	8·9	9·9	7·8	7·6	7·9	8·4	9·9	11·1
Iron of various kinds	58·8	65·0	66·7	66·0	60·7	69·2	73·4	71·8	72·9	77·4	75·5	72·4	71·9	68·5	70·4
	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0

The weights given in this Table, with the exception of machinery, are not reduced to their equivalents of pig iron in the manner observed on some previous occasions.

So far as these calculations enable us to judge, the demand for iron for uses other than railways has increased more rapidly than that for rails, &c. A considerable portion, however, of the machinery (about one-third) was for steam-engines, and of these a large number would be locomotives, and must therefore be considered as appertaining to railways. Admitting the whole of the third part to be locomotives, which is not true, we would have:—

	Railways and Locomotives.	Machinery other than Locomotives.	Iron of Various Kinds
1870 . . . per cent.	37·2	4·0	58·8
1884 . . . ditto.	22·2	7·4	70·4

These figures may therefore justify the hope that the use of iron is extending into those requirements of life which are, it may be expected, less liable to those excessive fluctuations which have marked the progress of railways. This latter, indeed, in the case of the United States, has been apparently so capricious, that the idea which arises in the mind of any one, not well acquainted with all the circumstances, is, that more is occasionally being done there in the construction of new lines than the expansion of population and trade can call for.

Having previously attempted to explain the more purely statistical aspects of the American iron trade, we may now consider, shortly, the position and cost of the minerals, and the expense incurred in conveying them to the manufacturing centres.

When the fuel used for smelting iron in America is charcoal, it is usually to be obtained at no great distance from the mines which supply the ore, because, in most places where mining operations are commenced, the country is covered with forests. The great expense attending the burning of charcoal, and its conveyance to the furnaces, generally renders it more profitable to send the ore, particularly when it is rich like that of Lake Superior, to localities where pit coal can be had. Of the 2,352,000 tons of ore raised in 1883 near Marquette, only about 260,000 tons are smelted on the spot, the remainder finding its way to Chicago, Cleveland City, Pittsburg, &c. Such

metal as is made near the mines is obtained at a cost of 30s. or 35s. per ton for fuel alone, and then almost the whole of it is sent to the steelworks, where pit coal can be had for converting it into malleable iron, steel, &c.

Up to the present day, there is no district in the United States which can be compared with that of Lake Superior in the quantity and quality of the ore it has produced. In the year 1858 the total produce of the mines was under 23,000 tons. The year I visited the locality, 1876, the output was under a million tons, a quantity which it was supposed it would be difficult to surpass. Nevertheless, the supply from these mines went on steadily increasing, until in 1882 it reached 2,948,000 tons, of which, however, 1,125,000 tons was from newly-opened ground in the Menominee Range. In that year the total make of pig iron in the United States was 5,178,000 tons, of which fully one-third was derived from the ore obtained from Lake Superior. Much of the produce of this district contains 65 per cent. of iron, and a good deal of it is so free from phosphorus that it furnishes excellent pig iron for the Bessemer process.

The coke used in Chicago to smelt a mixture of the Lake Superior ore and brown hematite obtained near Milwaukee is brought from Pennsylvania, chiefly from Connellsville, a distance of about 450 miles, the furnaces thus lying about midway between the ore mines and the collieries. The lake freight varies considerably in its amount at different times, but having regard to all the circumstances, I estimated that the expense of bringing the materials together, at Chicago, cost in 1876 not much under 35s. on the ton of pig iron produced.

At Cleveland City, on Lake Erie, the cost of bringing ore from the mines near Marquette was 14s. 9d. per ton. The fuel was partly from Connellsville, a distance of about 170 miles, and partly raw coal from Briar Hill, 50 or 60 miles from the furnaces. The cost of conveying the materials to the works was, in 1876, 32s. to 34s. on the ton of pig iron.

The mines of Lake Champlain produce a large quantity of

very rich ore, the output in 1881 having reached 637,000 tons. A considerable portion is sent to the ironworks in the coal districts, but some is smelted near the mines. As nearly as I could ascertain, the cost of bringing the materials to the furnaces exceeded 20s. on the ton of pig iron, the coal having to be brought, by a circuitous route, a distance of more than 300 miles, to which must be added a not inconsiderable sum for taking the iron to a market. In 1874 anthracite coal, the fuel used at the Lake Champlain works, was being charged 12s. 3d. at the pits.

Of the entire make of pig iron in the United States, Pennsylvania contributes fully one-half. In 1883 the production was 5,146,972 nett tons, and in 1884, it was 4,589,613 nett tons. Of this Pennsylvania furnished 2,638,891 and 2,385,402 tons in these two years. This position it owes, in a large measure, to its extraordinary wealth in coal, for the ores smelted in the blast furnaces of this State are chiefly derived from other more or less distant parts of the Union. Lakes Superior and Champlain have already been mentioned. New Jersey, for many years past, has supplied considerable quantities to the Pennsylvanian furnaces, for out of 900,000 tons of ore, the produce of its mines, not one-third was smelted in the New Jersey works. The Cornwall mine in Lebanon County, Pennsylvania, is an immense deposit of ore, and is one of very cheap extraction, costing it was said not much above 1s. per ton for labour. The selling price in 1874 was $4\frac{3}{4}$ dollars, equal at that time to 17s. 10d. per ton. The selling price of the Lake Superior ore delivered at Cleveland City in 1883 and 1884, in dollars, was as follows :—

	1883.	1884
Republic Mine	7·50	6·00
West Republic	7·50	6·25
Barnum, Cleveland, and Lake Superior Specular	6·50	5·75
Chapin and Menominee	6·00	5·25
Hematites	4·75	4·50

The present value of the dollar is 4s. The cost of carriage to Pittsburg from Cleveland City is about 9s. per ton, including

cost of unloading, &c. Besides the rich ores of the Lakes and New Jersey, a certain quantity is brought from the Iron Mountain in Missouri by the rivers Mississippi and Ohio.

In Pennsylvania itself there are found deposits of brown hematite, which is smelted in the furnaces of the Lehigh Valley.

In the neighbourhood of the Cambria works at Johnstown, I saw the only instance of clay ironstone of the coal measures successfully dealt with in the Northern States.* For common iron a portion of ore was brought from distances of 68 and 77 miles. For Bessemer iron large quantities of Lake Superior ore were used, and the local fuel not being pure enough, a certain proportion of coke from Connellsville was found to be necessary.

In the year 1883 this Connellsville coke, which is much prized by iron-smelters, was sold, delivered in cars at the ovens at 90 cents, only 3s. 6d. per ton; and the railway dues to Pittsburg in 1874 were 4s. 6d. per ton. Anthracite coal, used in the Lehigh Valley and elsewhere, for blast furnaces, was charged at 9s. 4d. to 11s. 6d. at the pit, at the then value of the paper dollar, to which had to be added the cost of transport to the works, say 5s. per ton.

As a rule I found the railway companies in 1874 charged high rates on iron-making materials. At one work in the Susquehanna Valley the following were given me:—

	Miles.	Dollar taken at 8/9½.
		s. d.
Anthracite coal . . .	59	5 7¾
New Jersey ore . . .	150	9 8
Cornwall ore	25	3 1
Hematite	60	4 8½

From the information received upon the occasion of two visits to the United States, I estimated that the cost for trans-

* Near Marietta, in Ohio, there is a few furnaces built for smelting black band found there, but in 1876 all I saw in this district were out of blast.

port on iron-making materials in the Northern States, per ton of metal made at the following places, was as follows :—

	s.	d.
Pittsburg on Bessemer iron, 35s. to	40	0
Lehigh Valley—forge iron, without admixture of cinder, 15s. 6d. to	16	6
Cambria Iron Works—iron for rails	5	0
„ „ hematite iron for Bessemer . .	25	0
Susquehanna Valley	23	0

In the southern portion of Ohio, and extending into Kentucky, there is a valuable coal field, and in connection with it considerable quantities of clay ironstone are worked. In appearance and cost it resembled the ironstone of South Staffordshire. At the furnaces it was valued at 17s. per ton (1874), yielding 40 per cent., and the coal is charged at 8s. 6d. per ton, of which 2½ tons, used uncoked, were required for a ton of iron. The coal is brought from distances of 5 or 6 miles, and the ironstone mines vary from 3 to 13 miles from the furnaces. The cost, therefore, of carriage of minerals for the ton of iron must be considerably less than in Cleveland. On the other hand, the cost of the minerals themselves is very much higher. This district, known as the Hanging Rock region, produces an iron which is much esteemed, but in point of quantity it cannot be regarded as one of much importance.

So far as this description of the manufacture of iron in the United States has gone, it cannot be said that its conditions, on the whole, are favourable. For something like one-third of the entire make of pig iron, the ore—Lake Superior—and the coal are separated by a distance of nearly 1000 miles. In the more favourably situated blast furnaces, such as are engaged in smelting the New Jersey minerals, the distance between the coal and ore is about 80 miles, or more than three times that which intervenes between the Cleveland hills and the Durham coalfield.

The geographical position of the raw materials is of a very different character in the Southern States of Tennessee, Georgia, and Alabama. All three were examined by myself in

1874, but as more time was spent in the last named, and as the mineral field is within 200 miles of the coast, I will confine my observations to some description of its resources.

In Alabama are two rivers, running nearly due north and south, and separated at the town of Tuskaloosa by a distance something like 25 miles. The western one, the Black Warrior, runs into the Gulf of Florida at Mobile, and the eastern is the Cahawba River, a tributary of the Alabama River, which enters the sea (Mobile Bay) within 5 miles of the mouth of the Black Warrior. Each of these rivers runs through a separate coalfield. According to the analyses given me the ash in the coal was under 5 per cent., and the sulphur varied from ·27 to ·56 per cent. The fixed carbon runs from 54 to 60 per cent. At some elevation between the valleys of the two rivers just named is a third known as Jones Valley, which consists of Silurian limestone. On each side of Jones Valley is a bed of so-called fossiliferous ore, which is a red hematite. It has a thickness of 30 feet, but of this 22 feet is of a poor quality. Besides this variety of ore, there are large quantities of brown hematite. The fossiliferous ore contains from 45 to 60 per cent. of metal; an average may be taken at 50, for according to the books of the Eureka furnace, 2·06 tons were required to make a ton of pig. It moreover seems to be very free of phosphorus, the quantity of this dreaded metalloid not exceeding ·08, and often being as low as ·02 per cent.

We thus have a limestone territory, rich in iron ore, flanked on each side by a coalfield, affording, within a distance of 25 miles, all the minerals required for making excellent iron. To add to these advantages, labour is not much above one-half the price paid in the Northern States. The fossiliferous ore was only costing, when I visited the place, 1s. 10d. per ton for labour, and I saw no reason why the coal should not be worked at as cheap a rate as any of the coking seams in the county of Durham.

Upon the occasion of my examination of this locality railway

communication was very imperfect, but this, to some extent, has probably been improved. Recently it was stated that pig iron was now being made for 12 dollars, say 48s. per ton. With such natural advantages, however, as those just described, this cost of production ought, with proper means of intercommunication, to be considerably reduced.

The present condition of the Southern States is not such as to offer any great demand for home consumption of iron, and very long distances intervene between these new ironfields and the great centres of consumption in the North. As examples, Chicago and Pittsburg are 600 miles in a straight line from Tuskaloosa. On the other hand, the great stream of the Mississippi runs within 200 miles of this town, and once on it, it is easy to obtain access to the very heart of the densest populated districts of the Union. At the beginning of last year foundry pig iron was selling in Pennsylvania at 18 dollars per ton, at which time the value of Scotch pig iron in New York was 21 or 22 dollars, the price being about 50s. in Glasgow. The price now is only 40s. on the Clyde, or say 19 or 20 dollars at New York. There does not, however, seem any reason why, even at the present cost of Alabama iron, competition will not in time present itself at the doors of the Northern manufacturers, when the remedy which protects them from British iron will not be available.

It would, in the present state of our knowledge, be difficult to say what effect the development of the ironworks in the Southern States may have on our own export trade. The deepening of the Black Warrior River is already spoken of. With the facility this work would offer to ship iron in the Gulf of Florida, it seems not impossible that we may meet the iron of Alabama in some places now exclusively supplied from Europe.

When that day arrives, it will be difficult to see in what mode protection will be afforded to the dearer making iron centres, in which 30s. or 40s. are expended in merely bringing the materials together. Any import duty levied will equally

favour the better situated States in the South. This circumstance cannot fail to lead to a great extension of furnaces and mills in the Black Warrior and Cahawba Valleys, when all the iron makers in the North, at any distance from the sea coast, will be pretty much in the same position as if there were no protective duty.

I would now briefly summarise the conclusions which I have endeavoured to explain in this memorandum.

1st. That the minerals used in the present large centres of the iron trade occur, in nature, in the United Kingdom, under circumstances as favourable for economical extraction as they are met with in any foreign iron-making country.

2nd. That the position of our coalfields in relation to seaports is such, that we can receive and smelt foreign ores with greater economy than can be done by any other nation.

3rd. That while labour is more expensive in Great Britain than on the Continent of Europe, owing, in some measure, to the greater vigour of our miners, but perhaps more to the nature of the mineral deposits, the raw materials used in the manufacture of iron, taken as a whole, are sent to the surface as cheaply as is done in any neighbouring country.

4th. That railway accommodation for the transport of fuel ore and limestone is afforded on terms somewhat cheaper in Great Britain than those charged on the Continent for like distances. Further, that the geographical position of our minerals is such, that they can be brought to the smelting-works at a less outlay per ton of pig iron than is usually done abroad; and at the same time our furnaces, &c., are so placed that their produce can either be shipped at a mere nominal cost, or the expense for this work does not in any case greatly exceed one half of that incurred at the best situated foreign works. From this general statement respecting railway rates, the cost of conveying pig iron, steel, and malleable iron must, according to Sir B. Samuelson's report, be excepted, inasmuch as it would appear that these articles

are conveyed on cheaper terms abroad than in the United Kingdom.

5th. That, partly owing to the greater proximity of British minerals to the smelting-works, partly to the more general adoption of labour-saving arrangements, and in some measure to the character of our men, in spite of dearer labour, the ore is smelted and the resulting pig iron is converted into malleable iron or steel at a cost, taken as a whole, not differing materially from what similar work is performed for in Germany, France, or Belgium.

6th. That any advantage we possess in the economy with which our minerals are worked, or are transported to the works and placed on board ship, is not of such a nature as to enable us to undersell the foreign makers at or near their own works, even were the latter not protected by import duties. If then we can deliver iron, in any form, in any of these countries on more favourable terms than can be done from the native works, it must be due to the carriage being less from the British work to the port of delivery than it is from the foreign manufactory. In the same way, it may occasionally happen that the cost of sending articles to some port of Great Britain from the Continent may be less than from an English ironwork to the same place. This, added to the circumstances connected with the German export trade already explained, may enable the Rhenish manufacturers to obtain English orders. So far as my judgment goes, I deem it impossible that *cheaper labour* or *greater manufacturing skill* places the foreign works in a position to produce and ship iron more cheaply than is done in our own country for purposes of exportation.

7th. That in the case of machinery, and, as I am informed in that of iron shipbuilding, where skilled labour rather than physical endurance largely enters, the work is as well and more cheaply done than it is in Great Britain. Notwithstanding this, it has to be remarked that in machinery, as well as in shipbuilding, we stand, in point of amount, very greatly in advance of all foreign countries.

8th. That the geographical position of iron ore and fuel in the United States, as at present known, renders it impossible that the iron trade, as carried on in the Northern portion of the Union, can ever become one of a largely exporting character, so far as pig iron, rails, and other cheap forms of the metal are concerned. The disadvantage entailed upon the manufacture of iron by the distance at which the minerals lie apart is increased by the expense of sending the produce to a seaport, and, so far as the present time is concerned, by the very high price of labour.

To what extent the Southern States may be able to compete with Europe in an export trade, time only will show. Admitting, however, that all the expectations regarding Alabama, Georgia, and Tennessee, be realised, this can, in my opinion, only be done successfully when the cost of reaching the port of delivery is considerably below that from European ironworks.

9th. That the importance of scientific knowledge is recognised as fully, and applied as generally, in the manufacture of iron in Great Britain as it is on the Continent. At the same time, it must be admitted that foreign manufacturers enjoy the advantage of having a much wider literature dealing with practical questions on the subject than that possessed by ourselves.

Any attempt to explain a decline in the demand for iron involves an inquiry into the reasons why we are conveying less produce by sea and by land, why our mines are less fully employed, and our flax, woollen, and cotton mills are working short time, why there is less need for extending our gasworks or bringing water to our towns—in short, what is the cause of the human race requiring less of a material upon which every branch of industry and almost every human want is so greatly dependent.

The irregular nature of this demand has led to undue extension of ironworks, justified, perhaps, at the moment, but which

over a term of years, is more than the world requires. A period of depression sets in, and it continues, with greater or less severity, until the extension of human wants overtakes the means of satisfying them.

At the present moment it is difficult to conceive the creation of any enterprise which will require for its prosecution the amount of iron which has been absorbed by railways on land, or by ships on the sea. We must, therefore, rather look for an increased consumption among the millions of people who at present are consumers of very limited quantities of the metal. This, the experience of the last few years, induces me to hope may happen sooner than is expected by some people.

POSTSCRIPT, *March* 1886.—Since the foregoing pages were written, the Secretary of the British Iron Trade Association has issued his "Provisional Returns" of the make of pig iron, and of Bessemer steel, in the United Kingdom for 1885. As expected, there is a falling off in the production of both as compared with the previous year. Prices of pig iron have declined during the last month, Cleveland having been sold at less than 30s. per ton, and Scotch at about 38s. 6d.

The following are extracts from the document referred to:—

The total quantity of pig iron produced in the United Kingdom in 1885 was **7,250,657** tons, as compared with **7,528,966** tons in 1884; the decrease thus amounting to **278,309** tons, or **3·5** per cent. In 1884 the production of pig iron was 961,258 tons, or 11 per cent. under the quantity made in the previous year. The decrease in 1885 has not, therefore, been nearly so great as in the previous twelve months.

Of the fifteen districts into which the country is divided for iron-making purposes, four have increased and eleven have decreased their production of pig iron in 1885, as the following tabular statement shows:—

Table LXXX.

Production of Pig Iron in Different Districts, and in the United Kingdom as a whole, in 1885 *and* 1884, *with amount of Increase or Decrease in each District in the former Year.*

District.	Production in 1885.	Production in 1884.	Increase (+) or Decrease (−) in 1885.
	Tons.	Tons.	Tons.
Cleveland	2,458,889	2,484,340	(−) 25,451
Scotland	1,003,562	988,000	(+) 15,562
West Cumberland	688,040	814,956	(−) 126,916
Lancashire	678,619	706,607	(−) 27,988
South Wales	777,630	817,932	(−) 40,302
North Wales	36,766	27,804	(+) 8,962
South Staffordshire and Worcestershire	293,210	317,661	(−) 24,451
North Staffordshire	253,605	256,053	(−) 2,448
Lincolnshire	186,130	224,762	(−) 38,632
Northamptonshire	166,749	196,212	(−) 29,463
West and South Yorkshire	160,362	245,614	(−) 85,252
Derbyshire	363,387	337,936	(+) 25,451
Notts and Leicestershire	125,808	36,821	(+) 88,987
Shropshire	46,300	54,168	(−) 7,868
Gloucestershire, Wilts, &c.	11,600	20,100	(−) 8,500
Totals	7,250,657	7,528,966	(−) 278,309

It will be observed that the greatest amount of decrease has occurred in the three hematite iron-producing districts of West Cumberland, Lancashire, and South Wales; the proportions in which each has contributed to the decline being as under:—

	Tons.
West Cumberland	126,916
Lancashire	27,938
South Wales	40,302
Total	195,206

More than two-thirds of the total decrease thus appears to have occurred in the production of hematite iron. In the way of increase, the most remarkable advance appears to have occurred in the newest iron-producing districts in the kingdom—those of Leicestershire and Nottinghamshire, where the quantity of pig made in 1885 was 88,987 tons in excess of that produced the previous year.

On the 31*st* December 1885, the total quantity of pig iron